

What do forest fires, caribou, and monster truck tires have in common?

Matt Nolan



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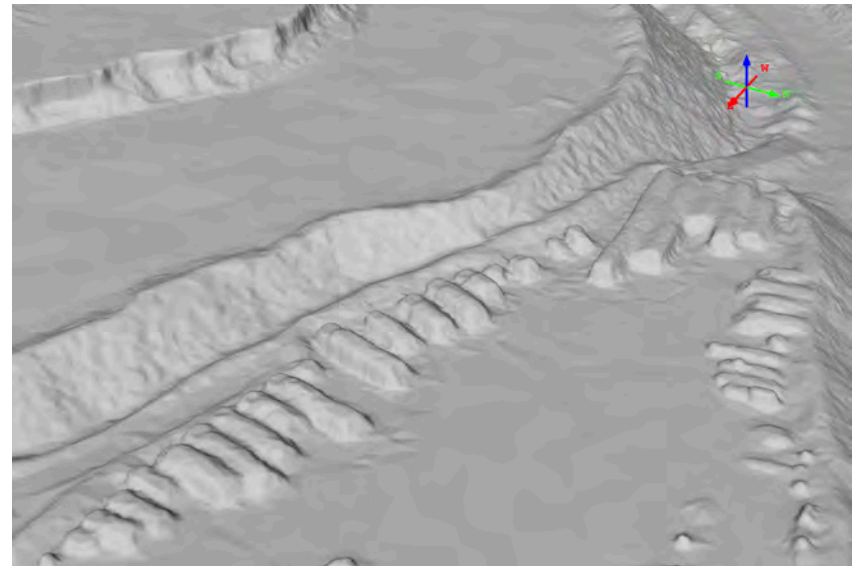
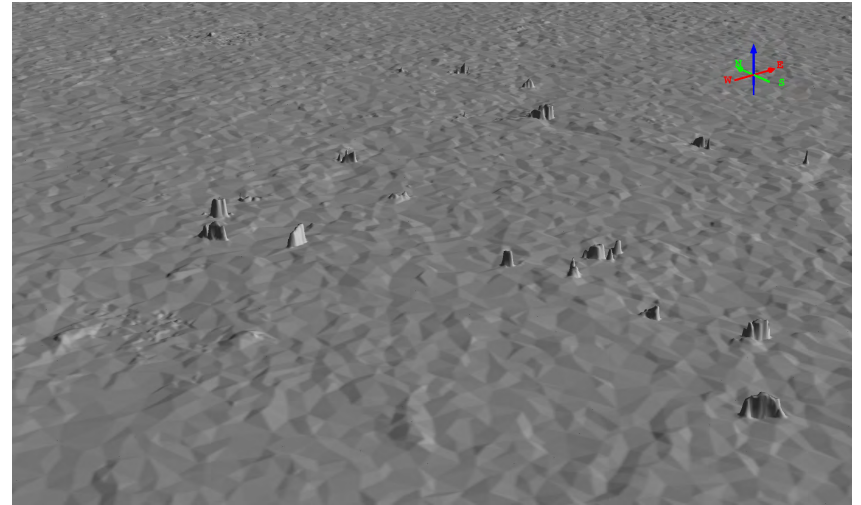
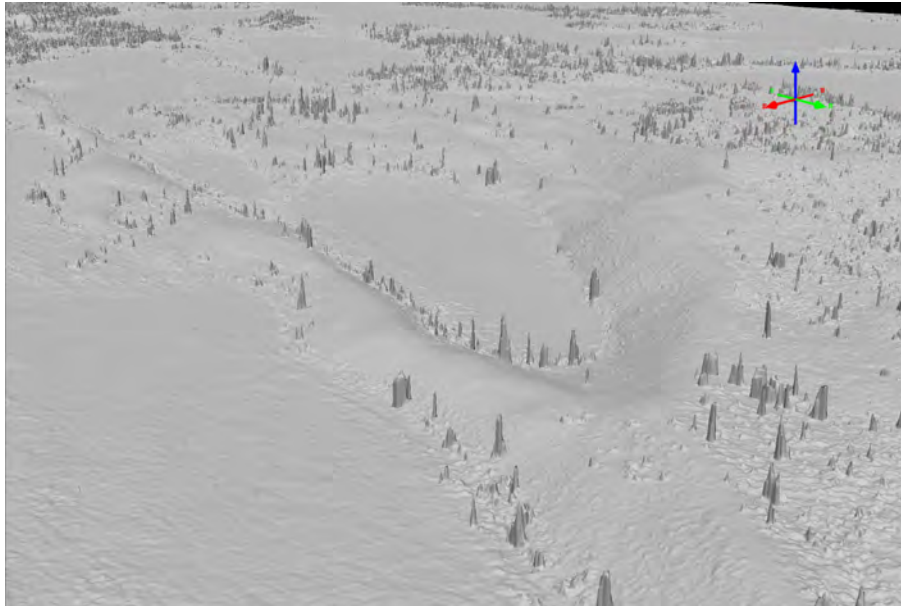


Short answer:

We can measure them all topographically,
and have been able to for decades.

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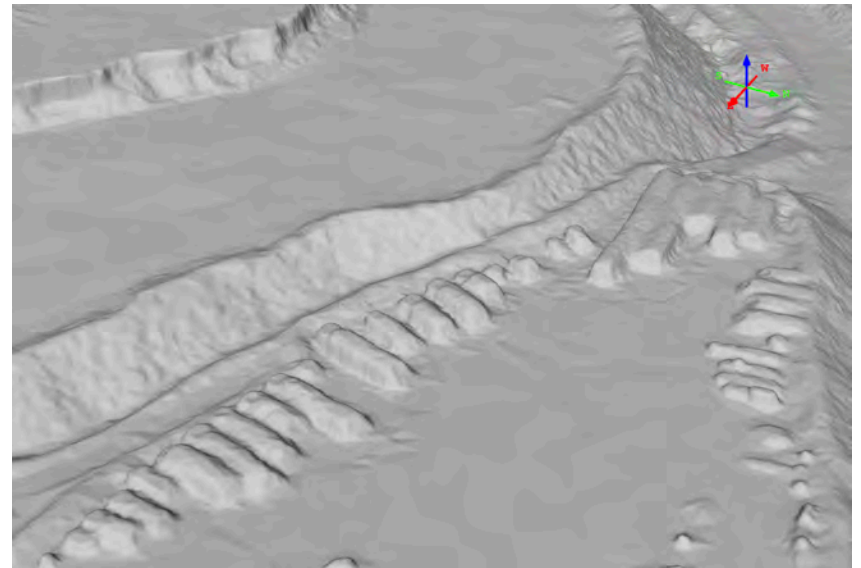
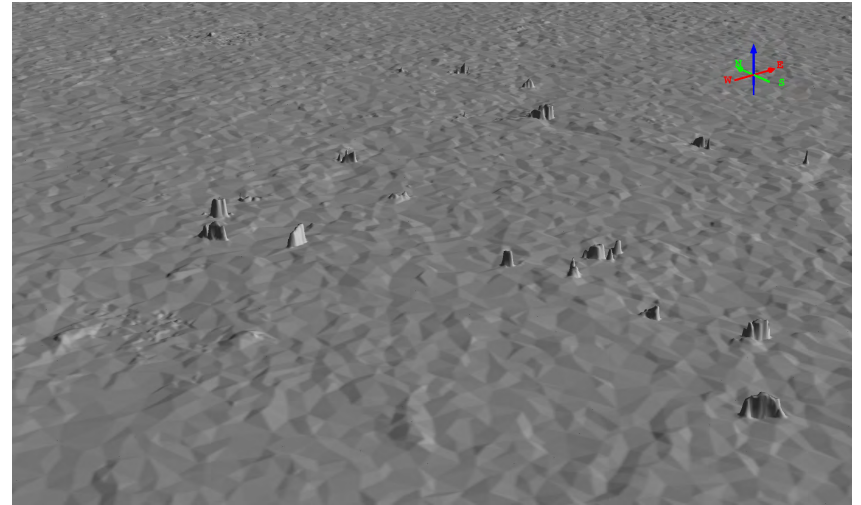
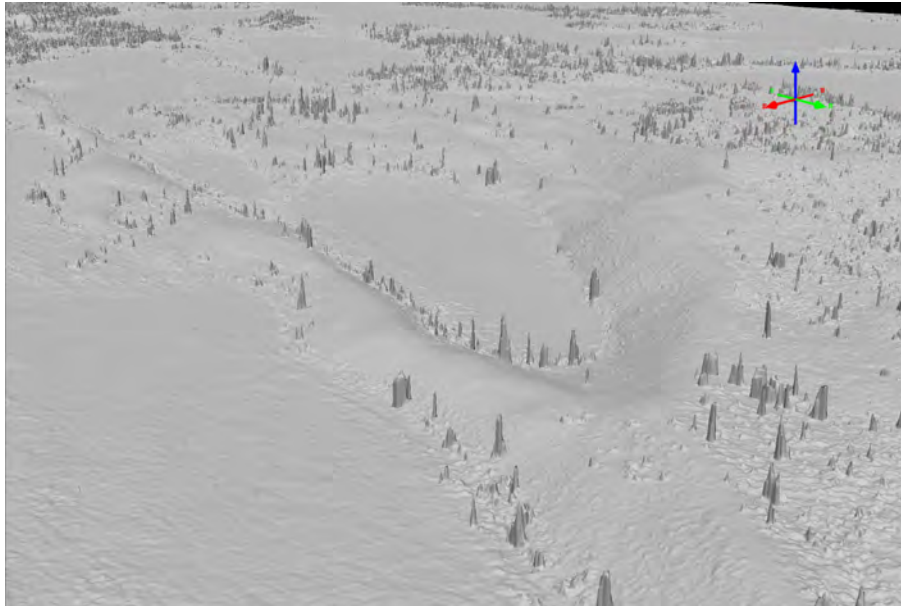


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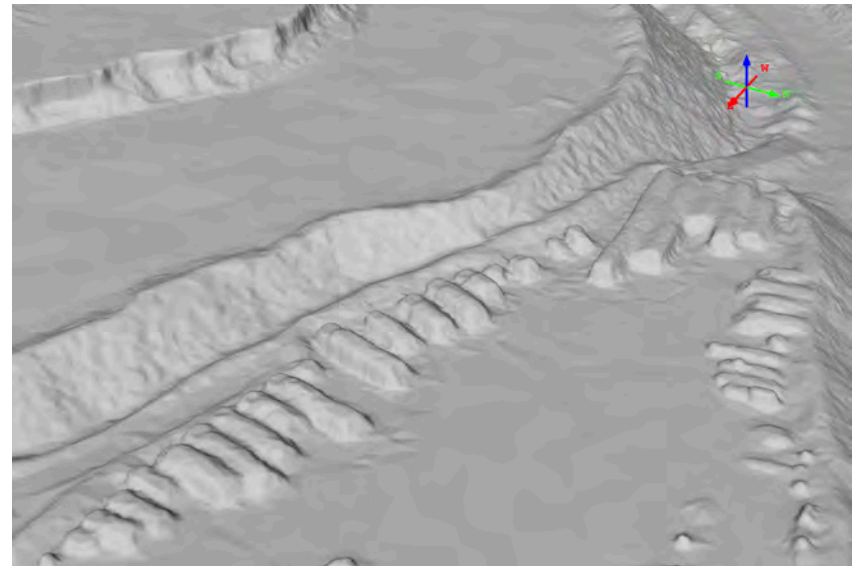
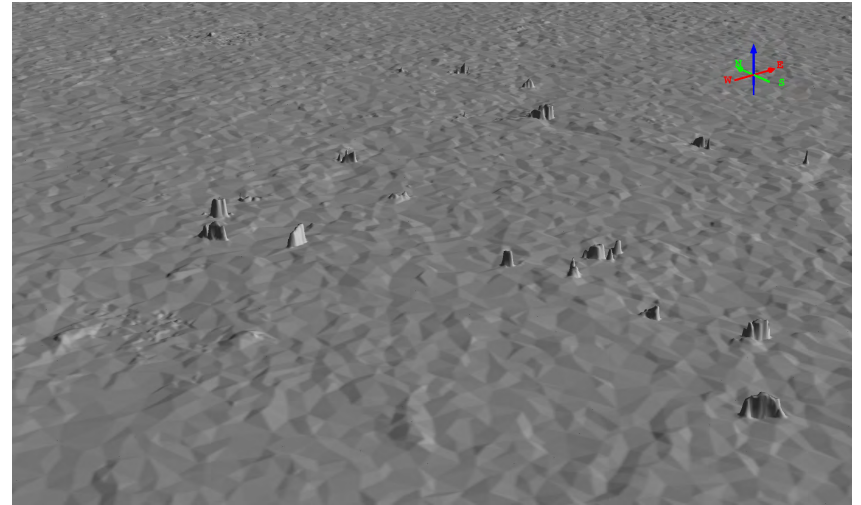
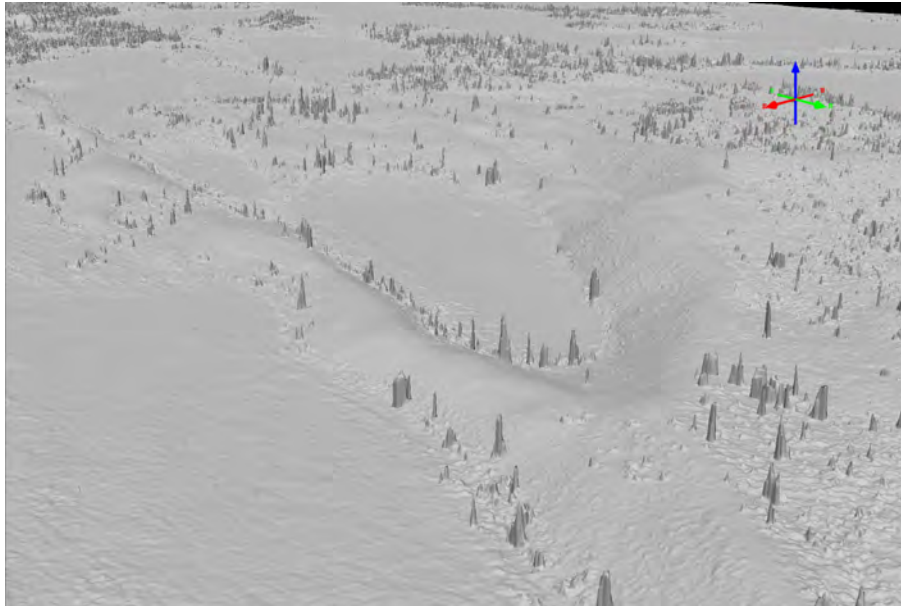
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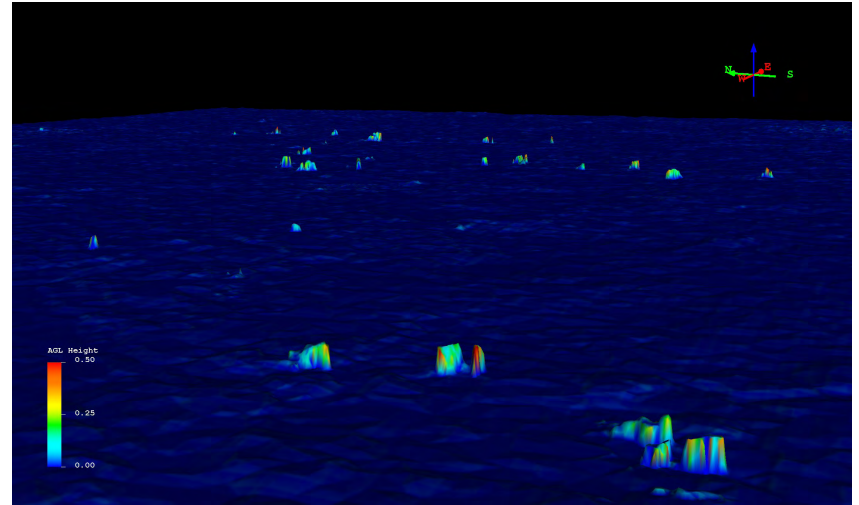
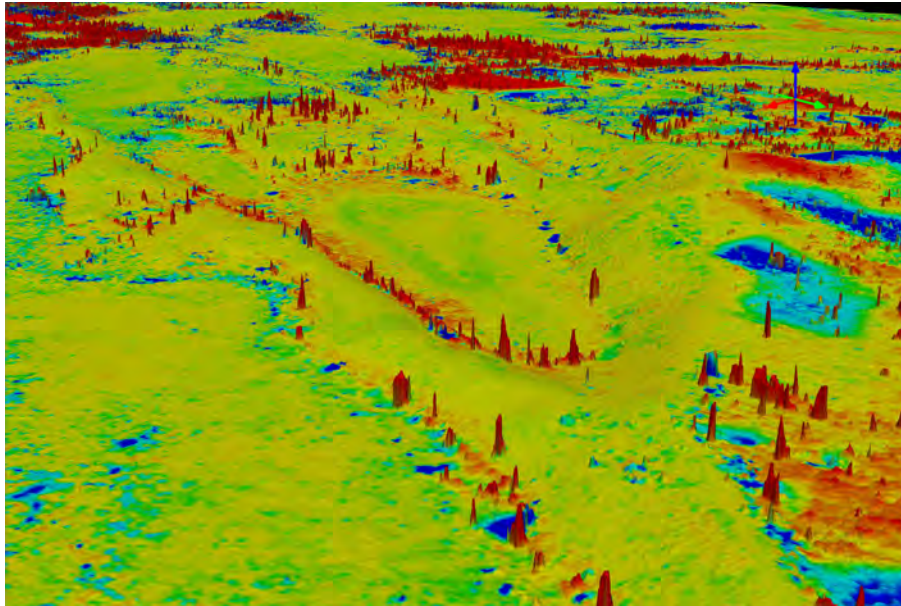


Longer answer:

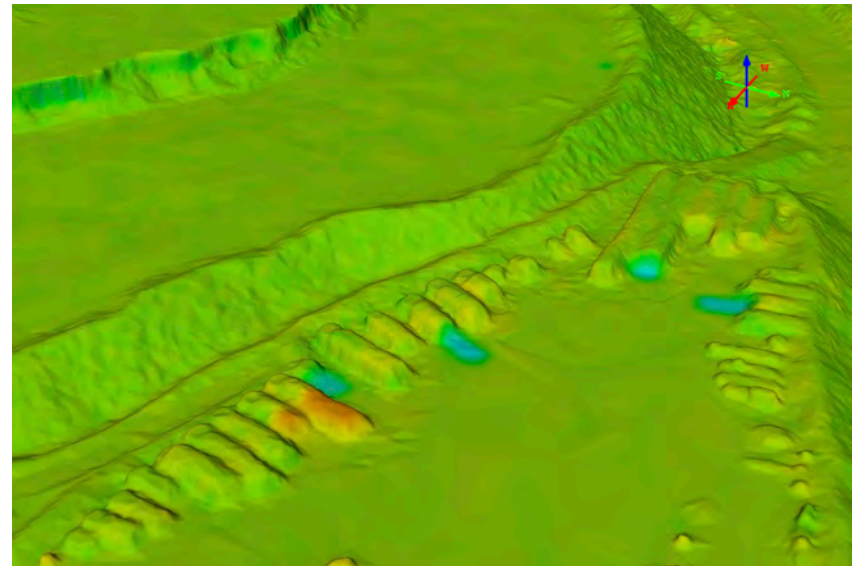
We can **now** measure *changes* to them
because **now** it is affordable.

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Longer answer:
We can **now** measure ***changes*** to them
because **now** it is affordable.

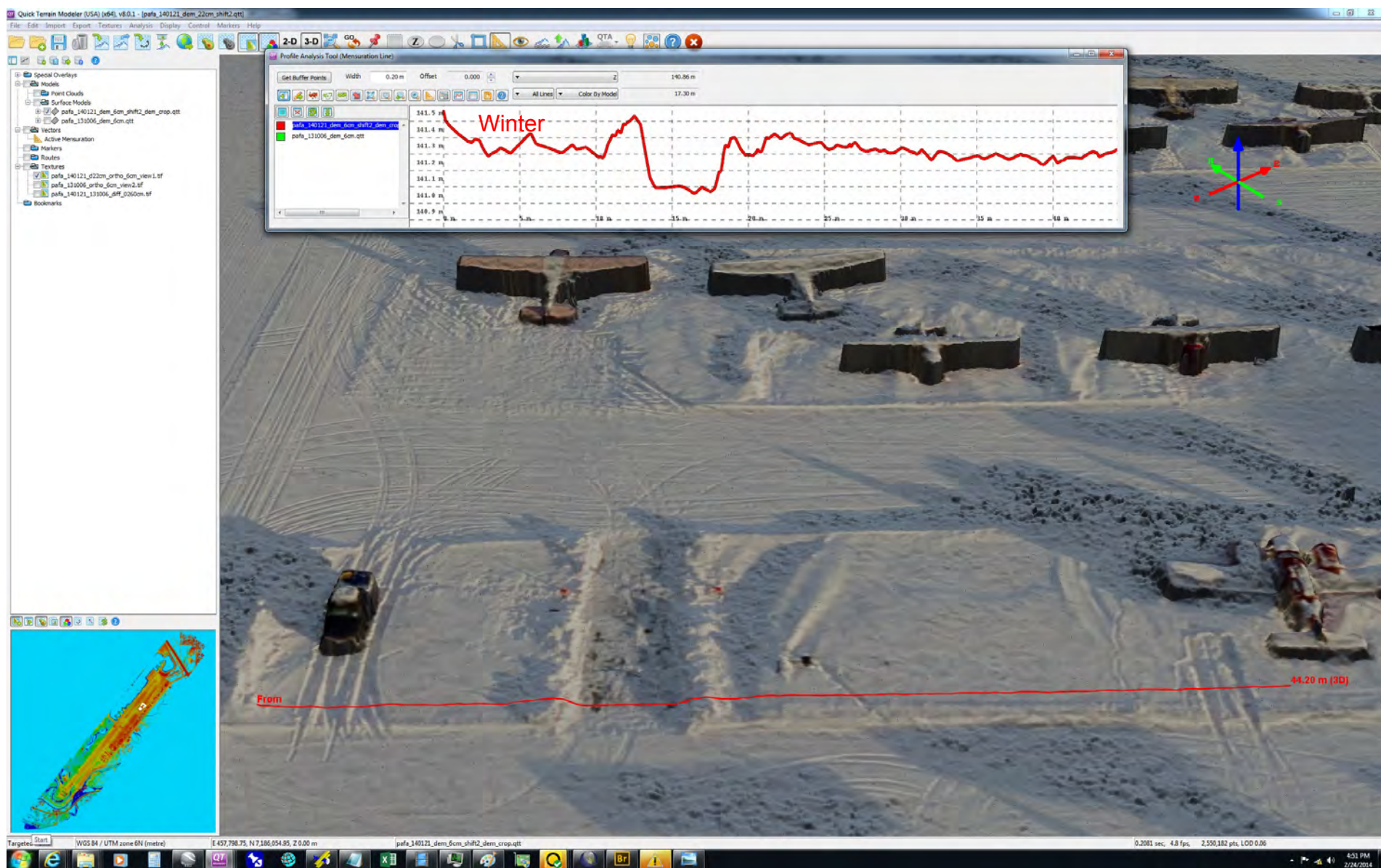


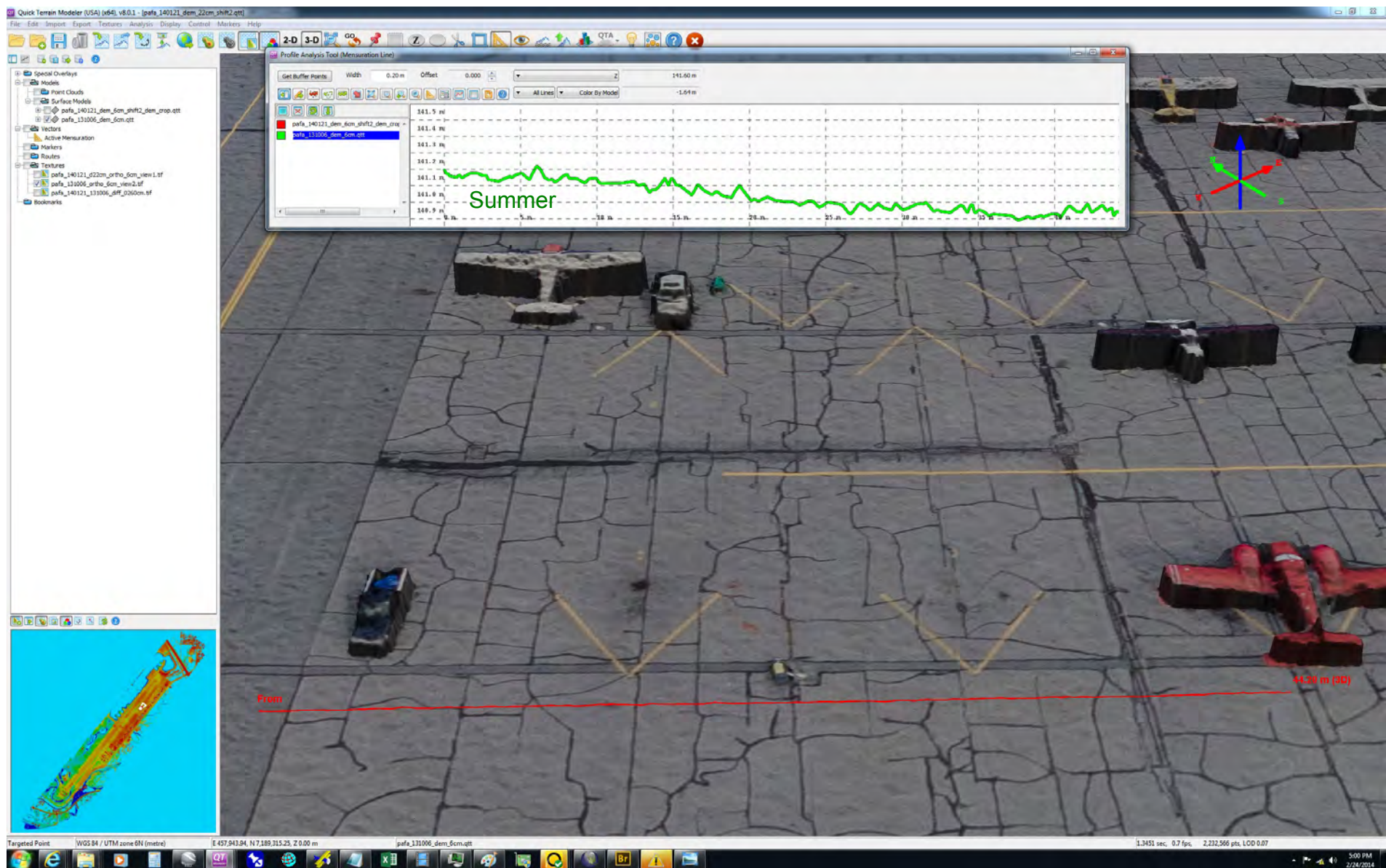
Your Take Home Message

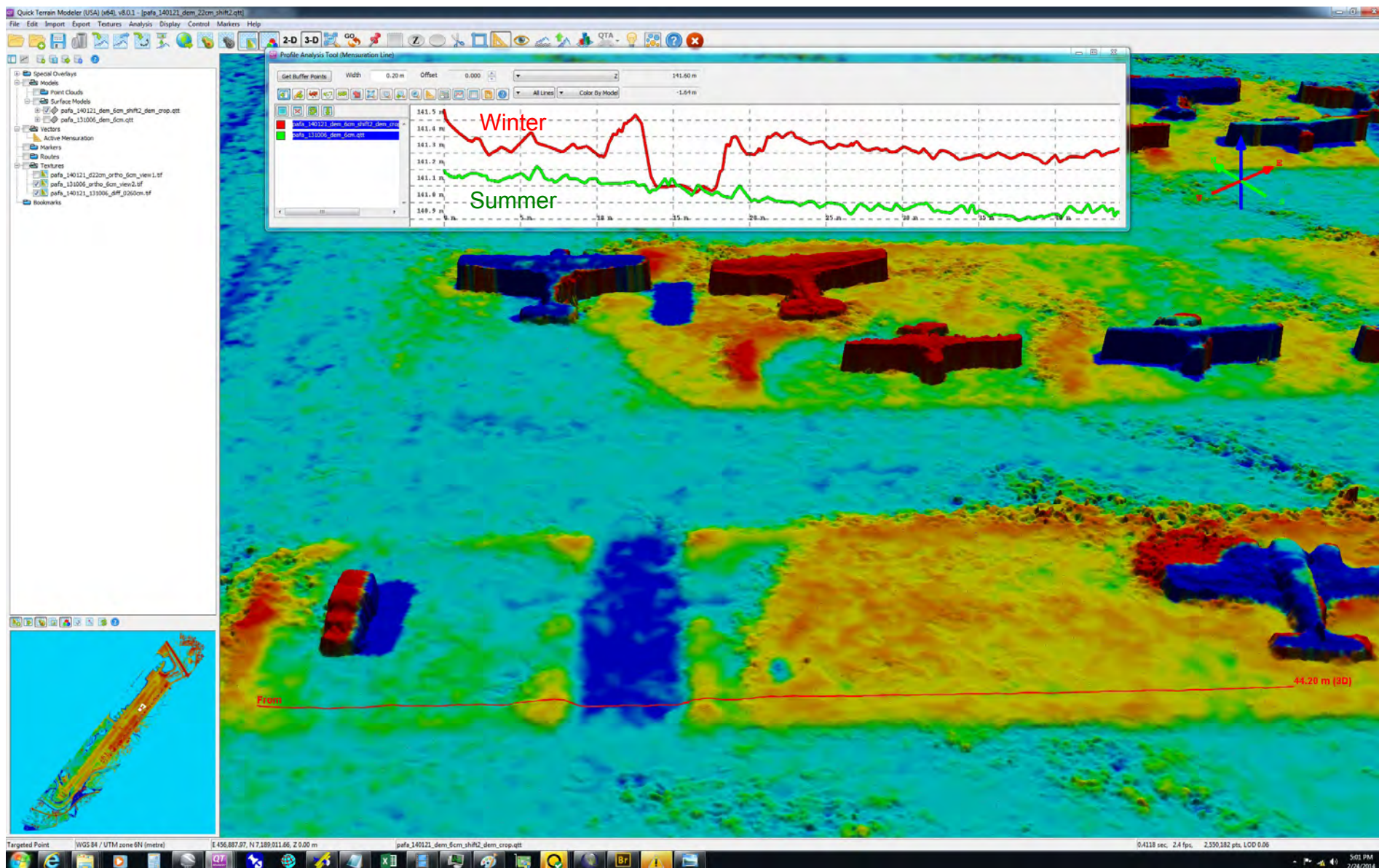
How would you design your research and field programs knowing that you can afford to make time-series of topographic measurements on an annual, monthly, weekly or daily basis?

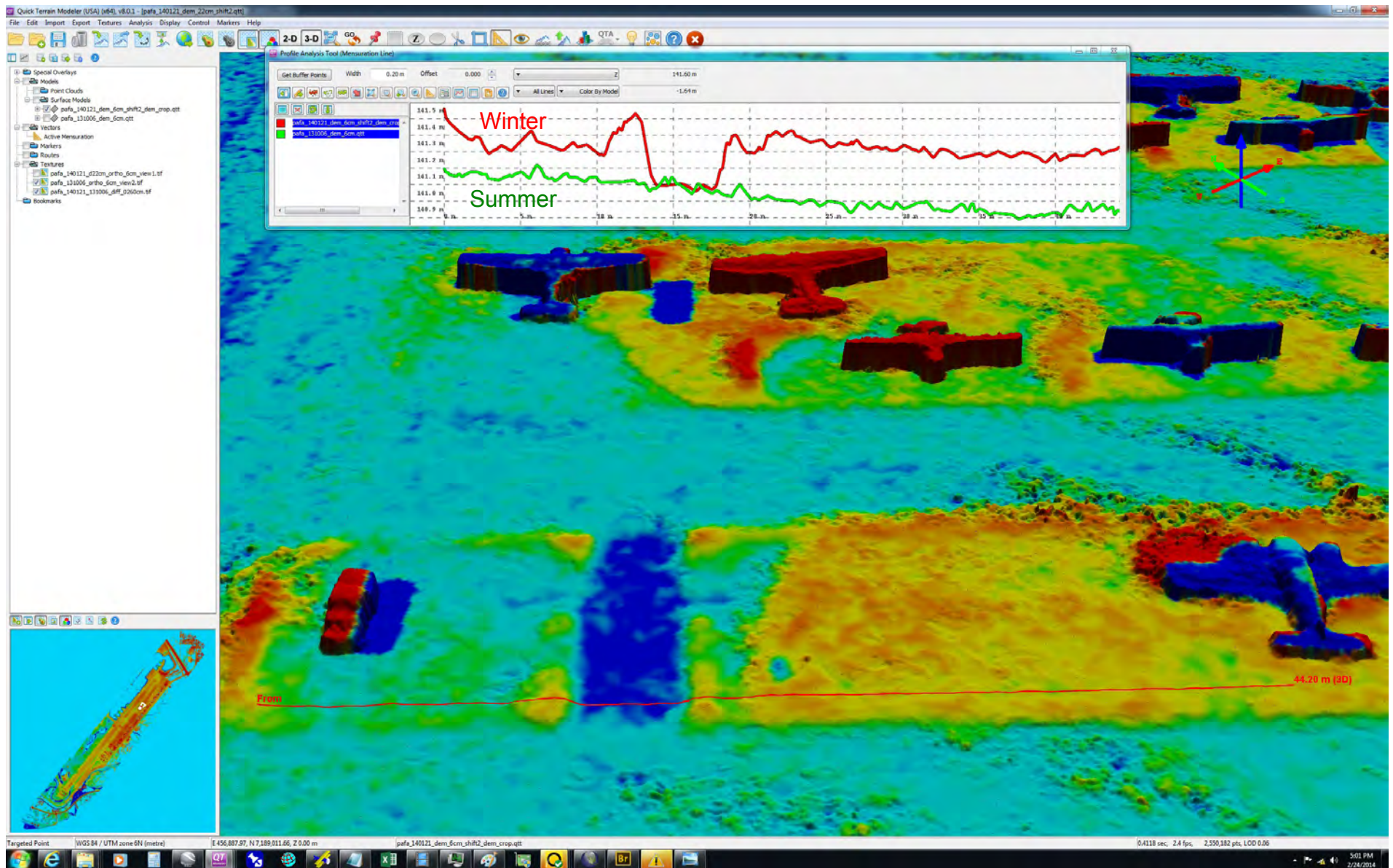
My Take Home Message

What are your unmet needs for research and management that could benefit from time-series of topographic measurements on an annual, monthly, weekly or daily basis?

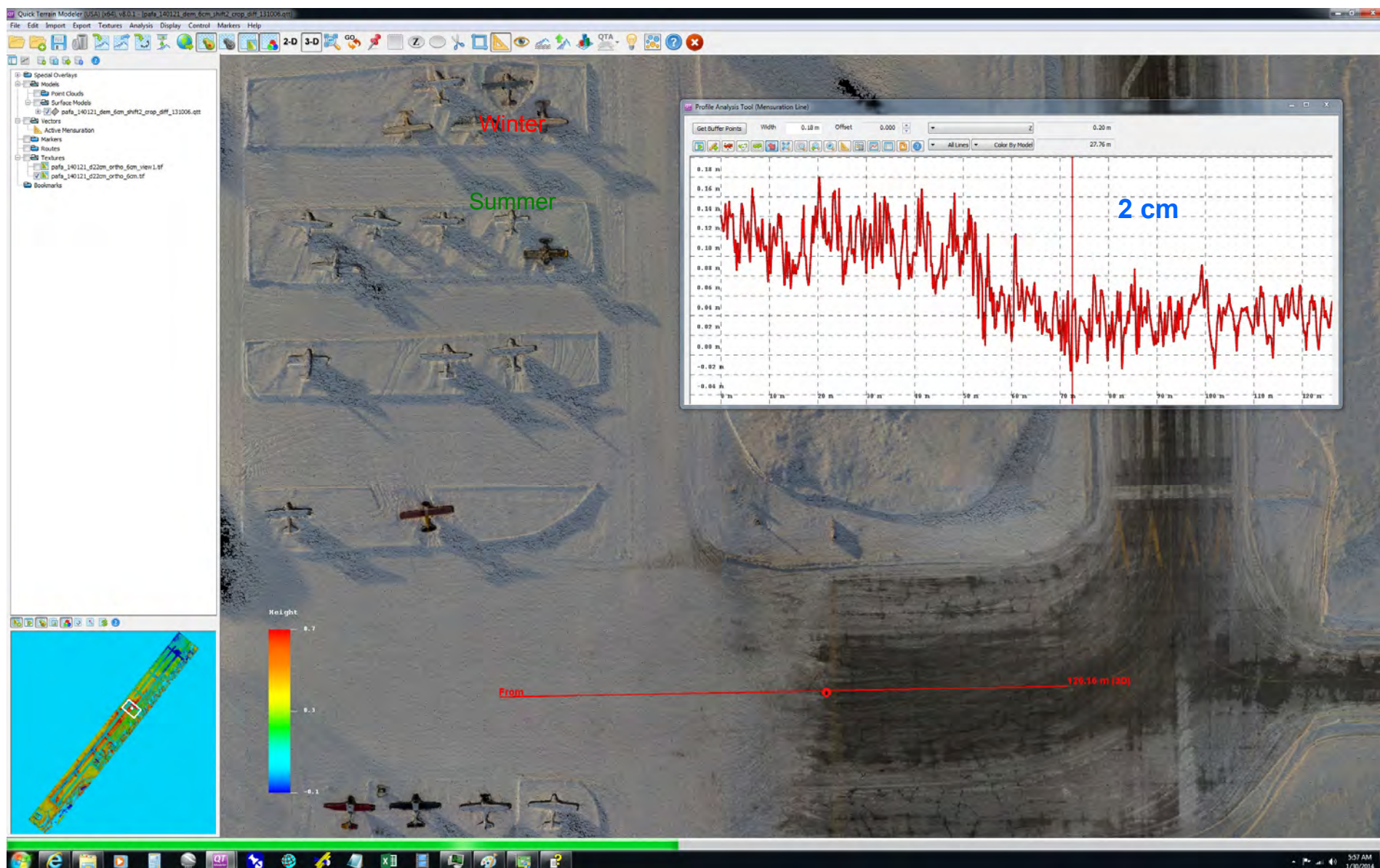


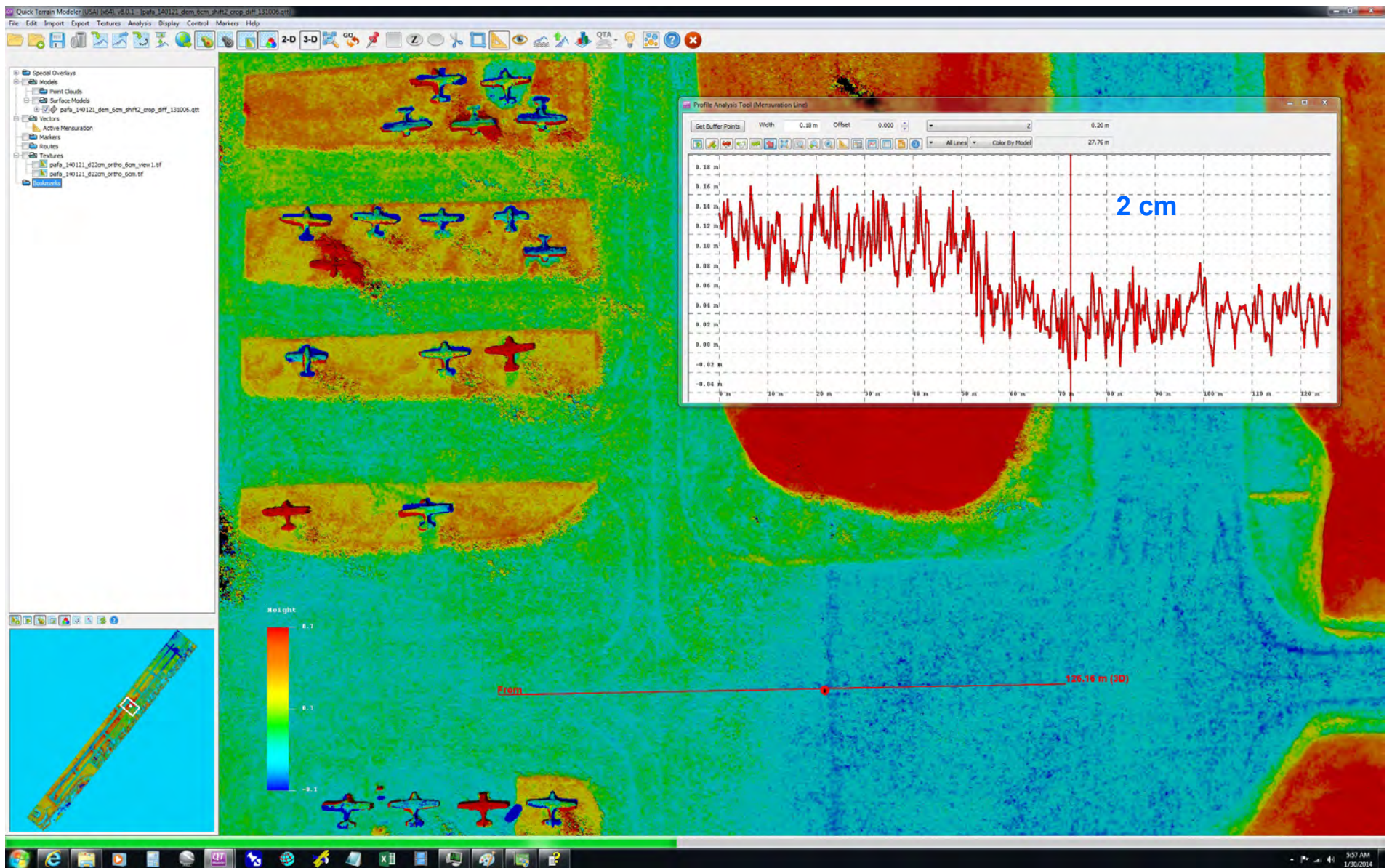


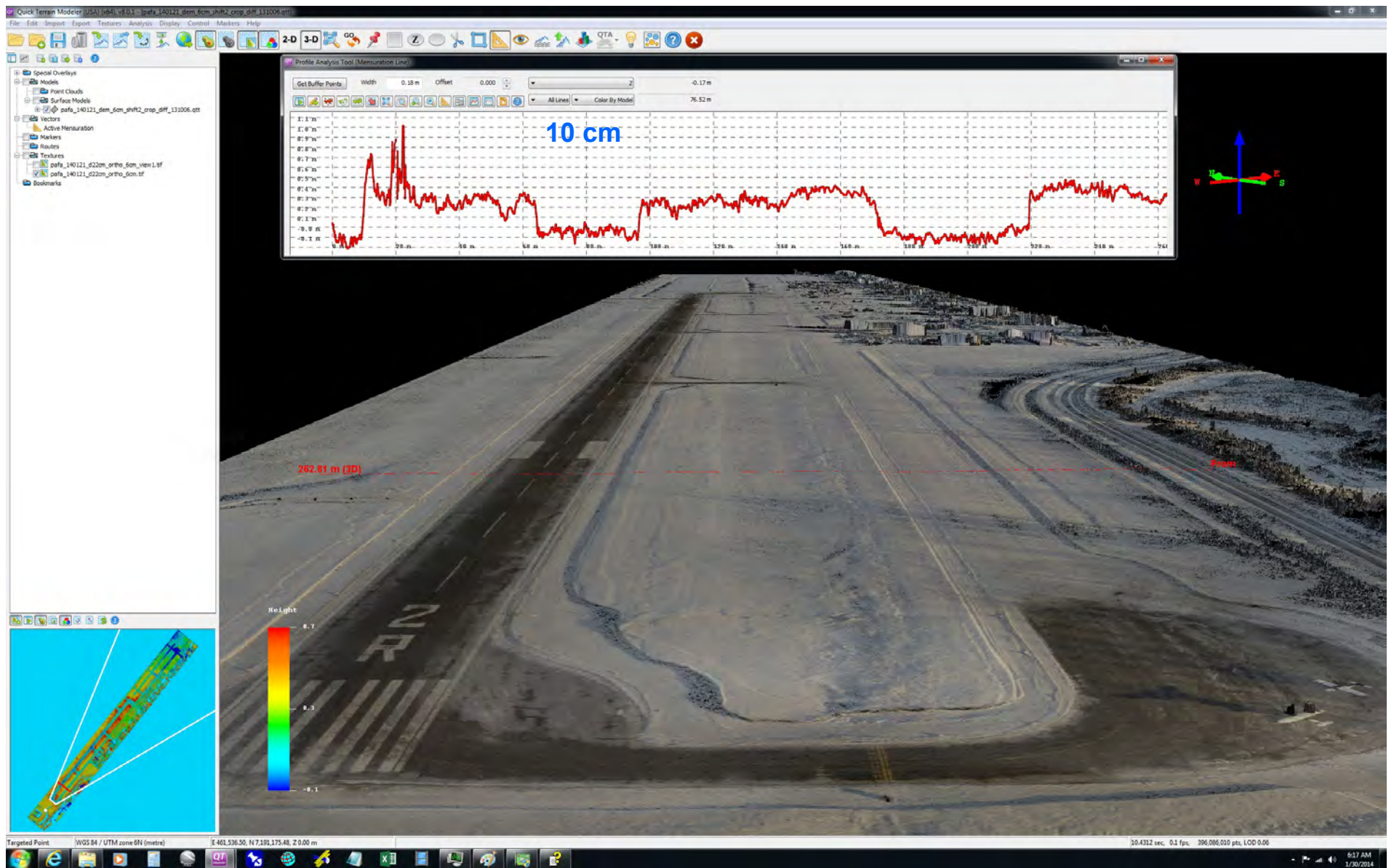


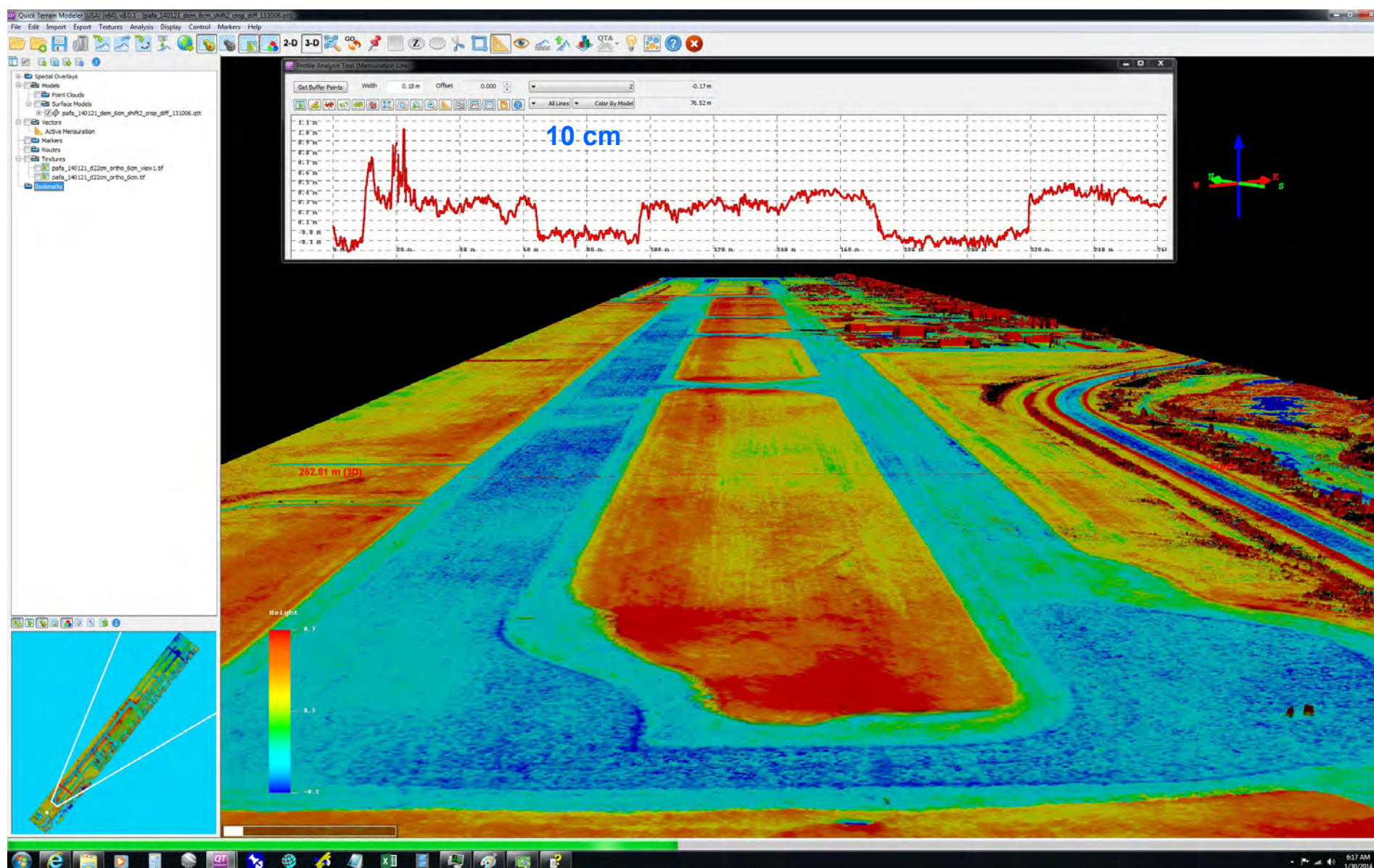


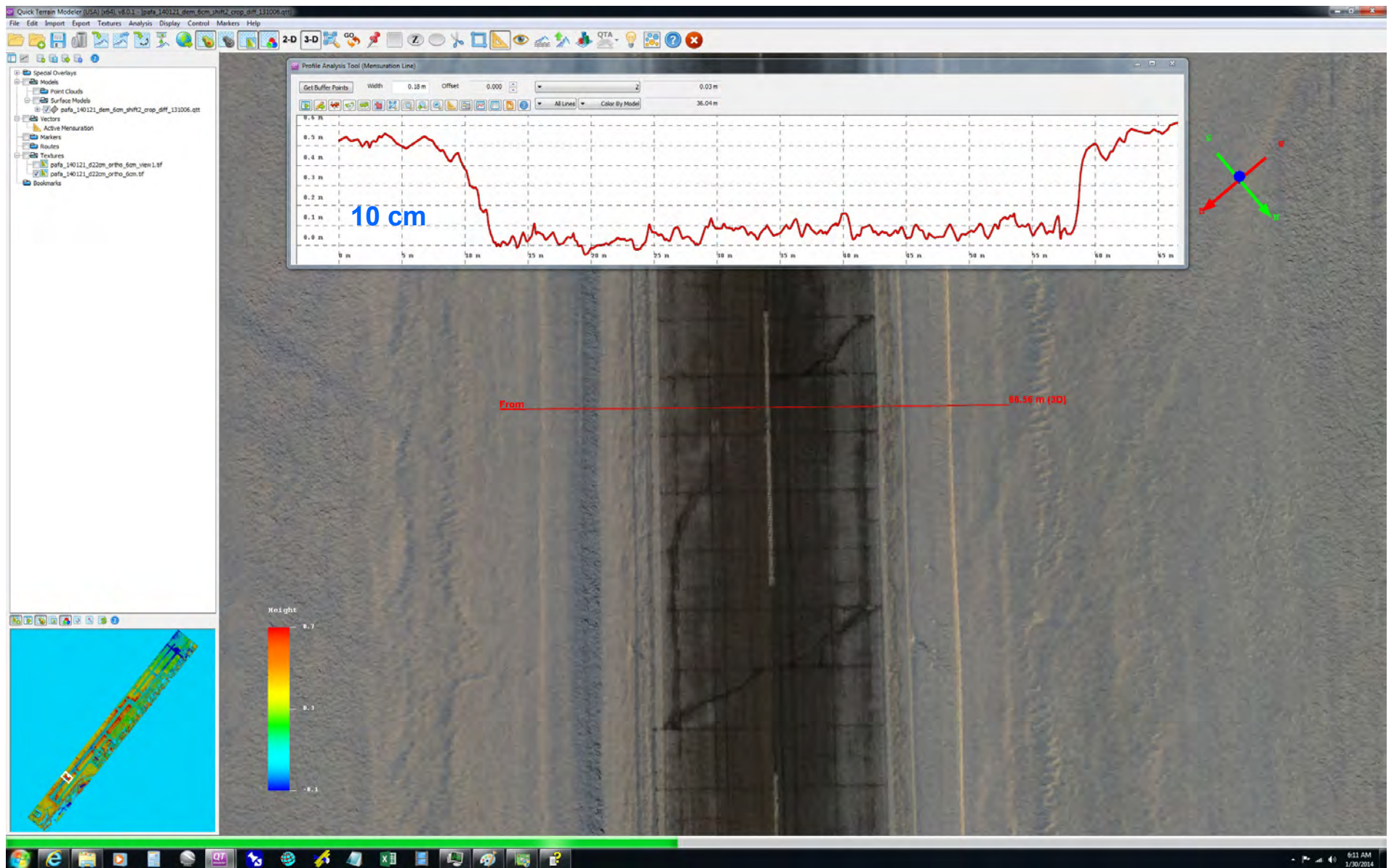
No ground control! Precision <10cm, Accuracy <1m

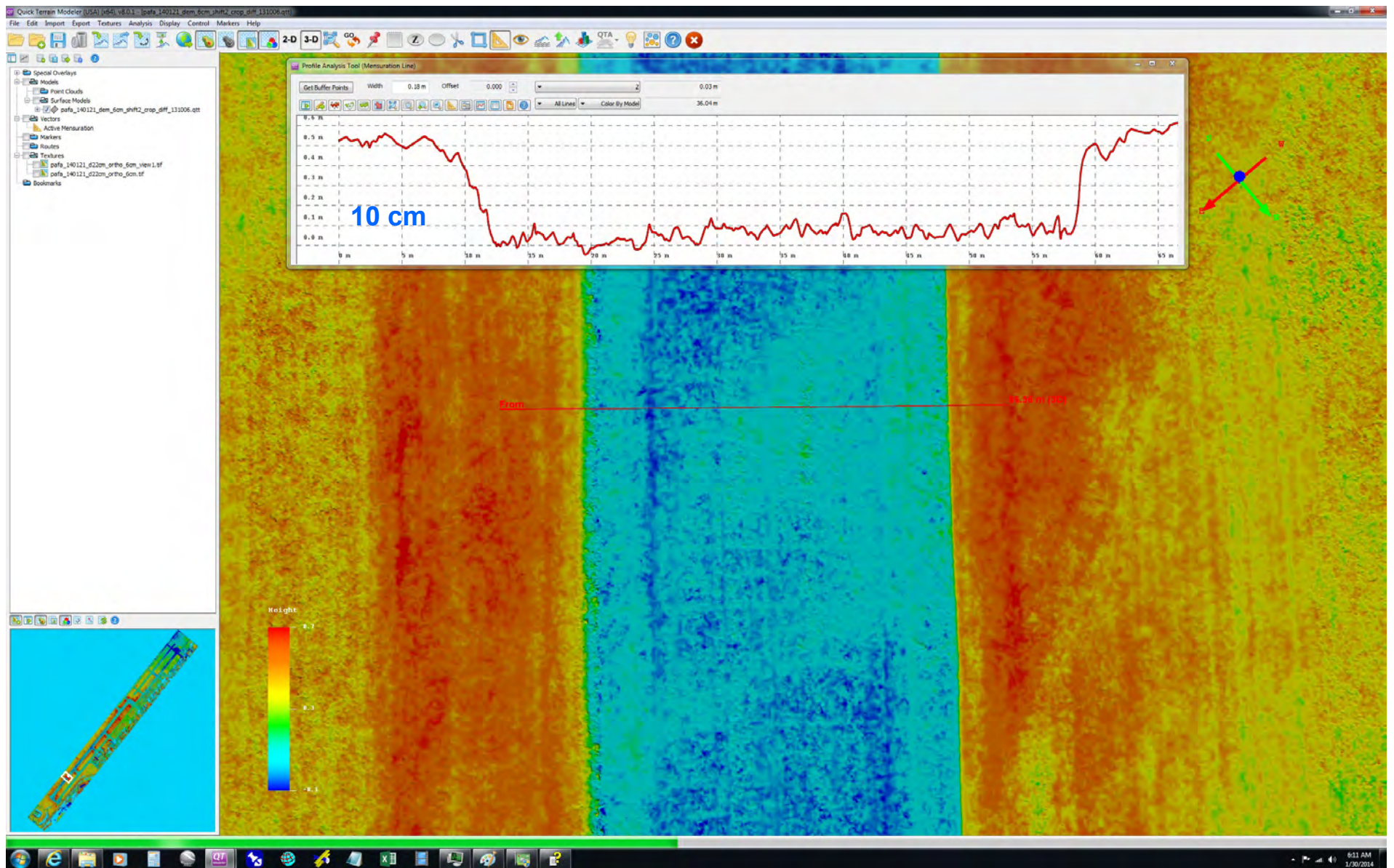






























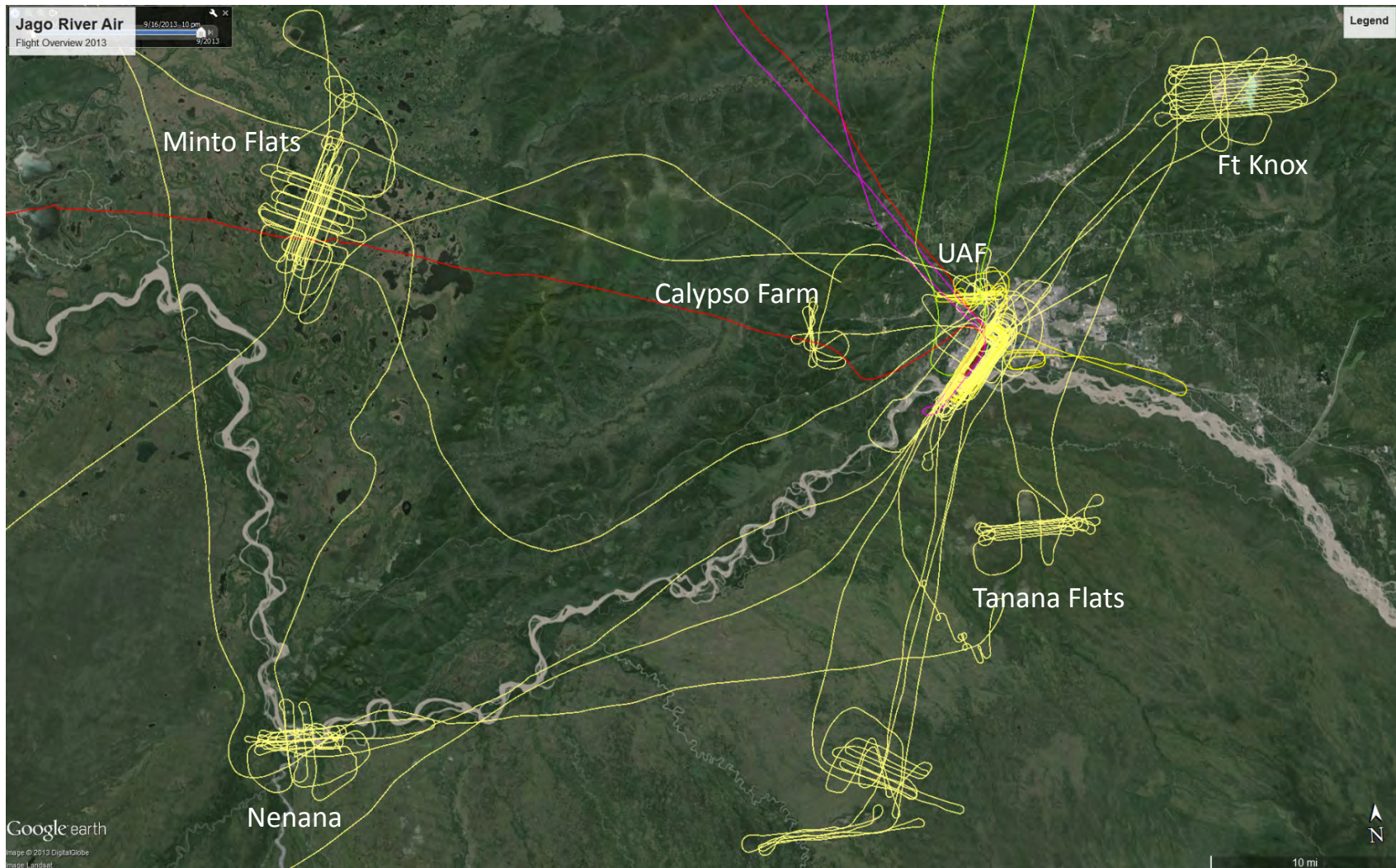
GPS

Intervalometer

Camera

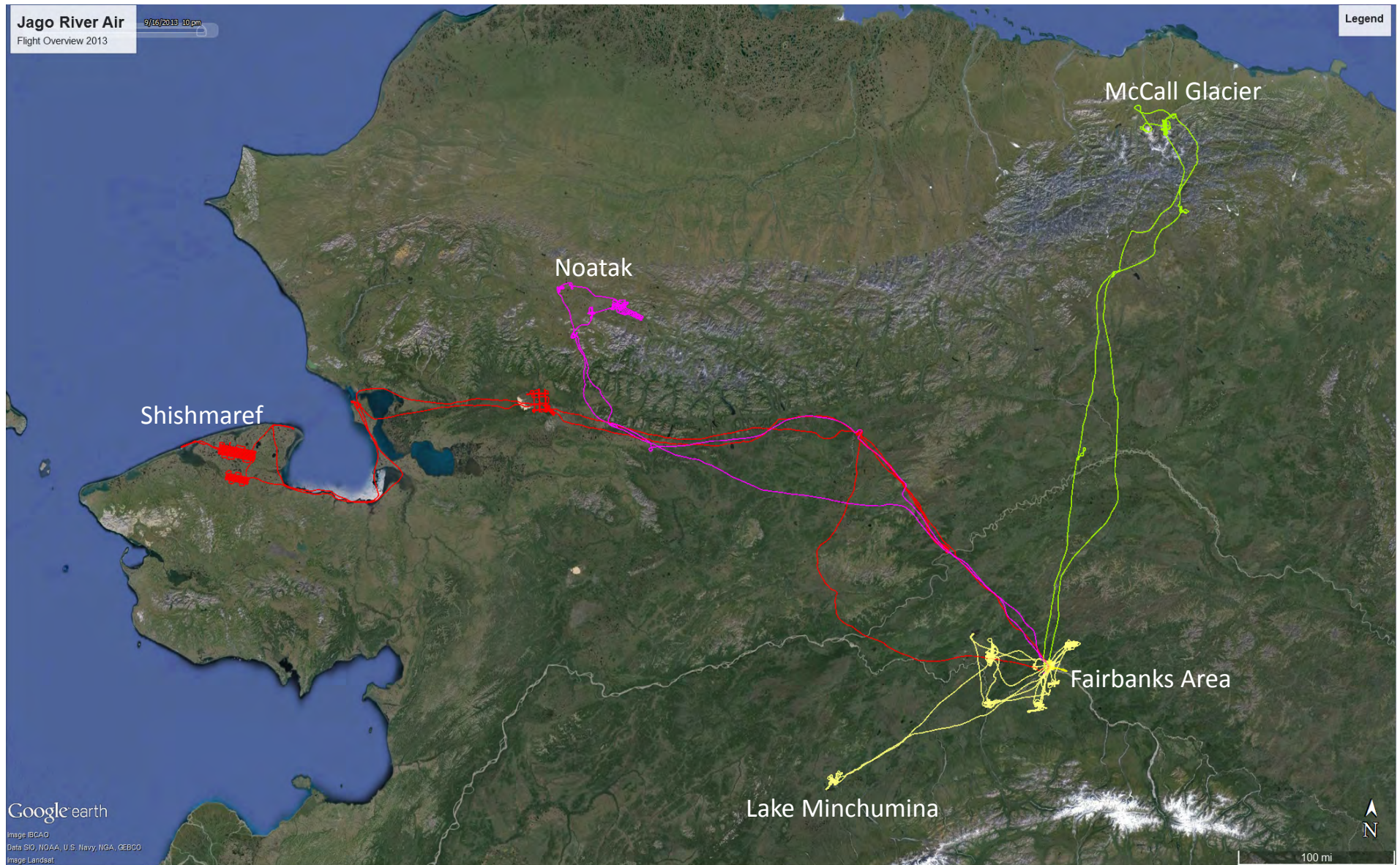
Cables

Local Testing Sites



I spent a lot of time refining and optimizing the system to improve it further, and still do.
Each of these sites has something unique to offer.

2013 Scientific Flights

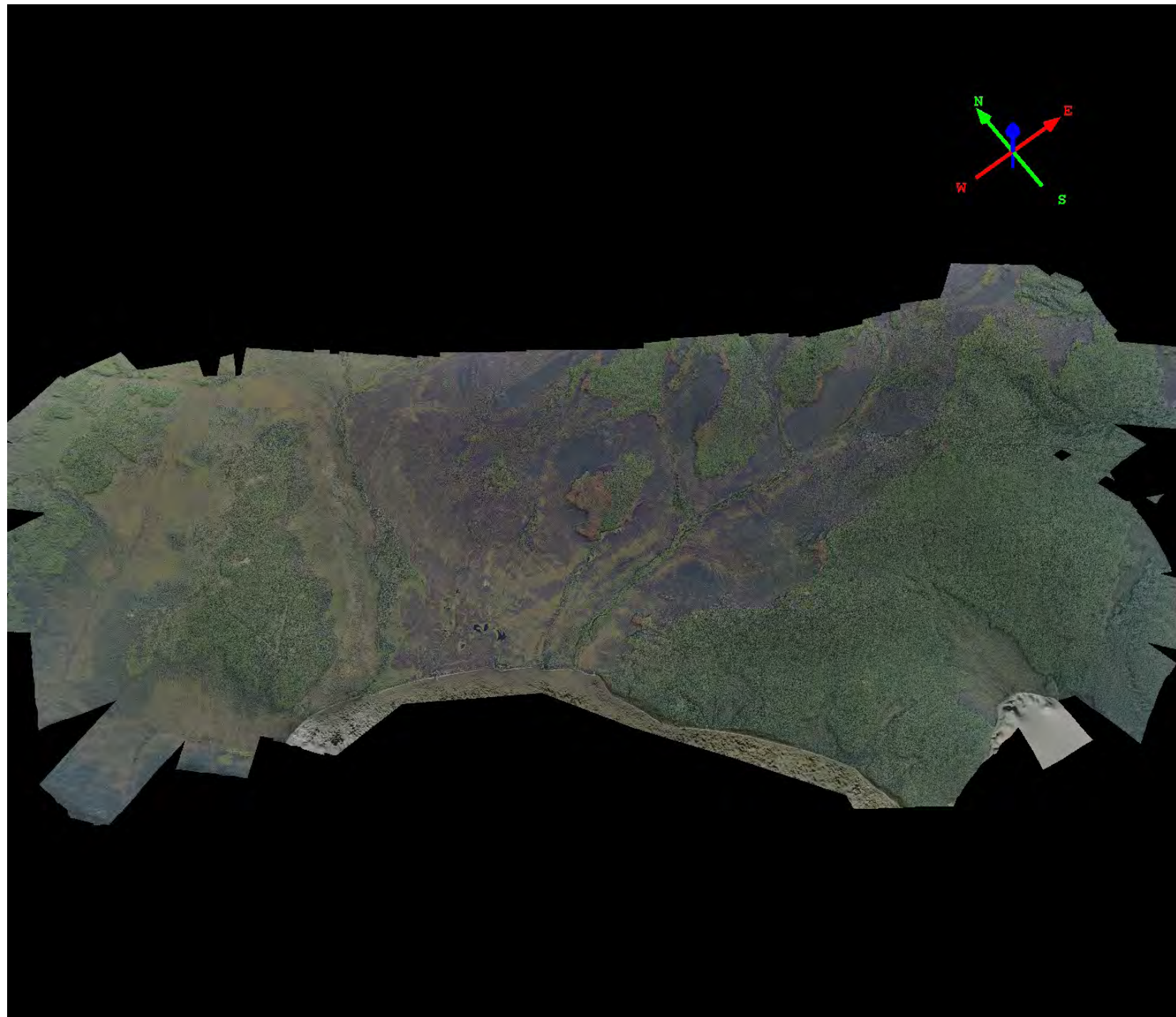


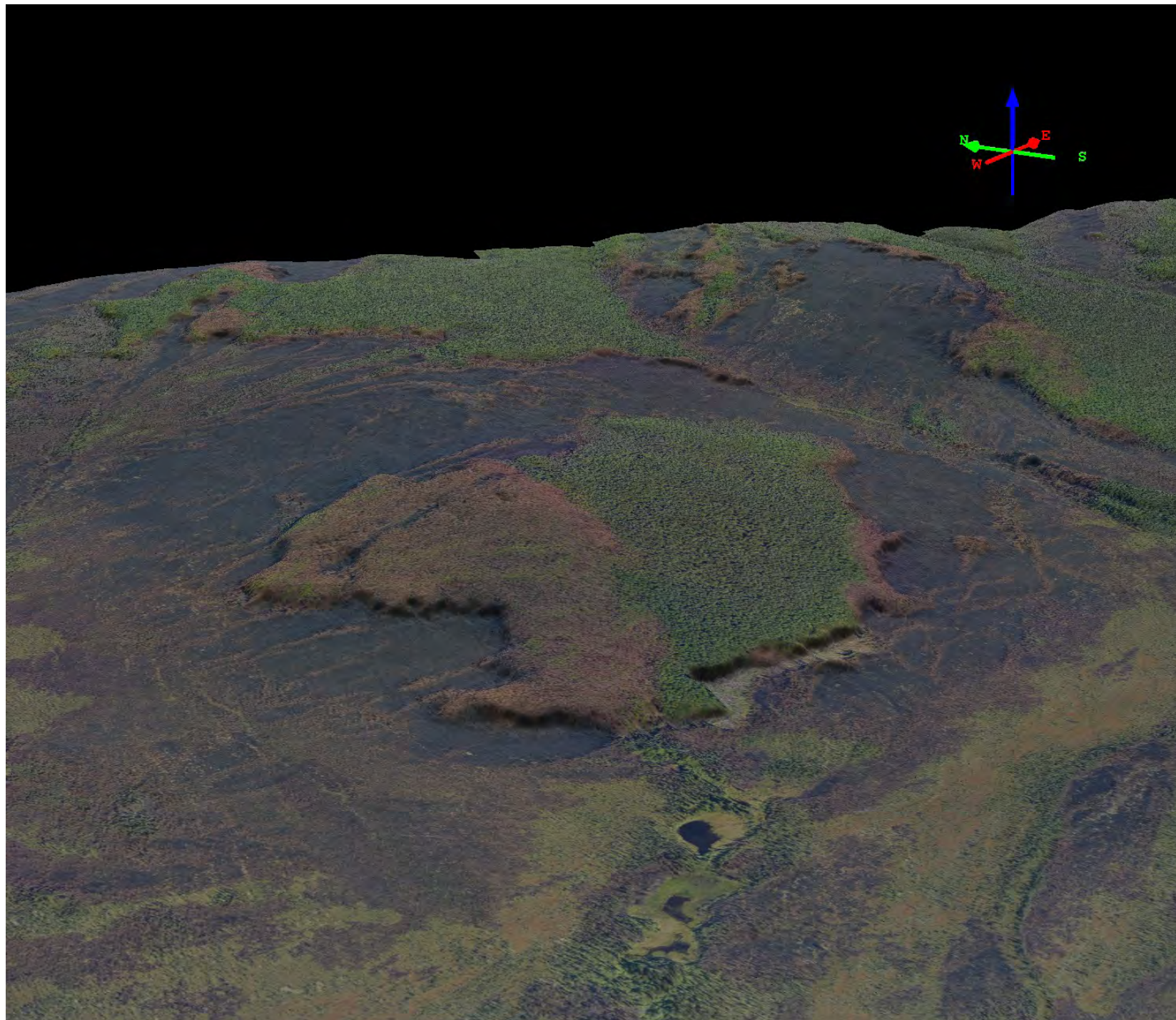
I flew these missions in September and October of 2013.

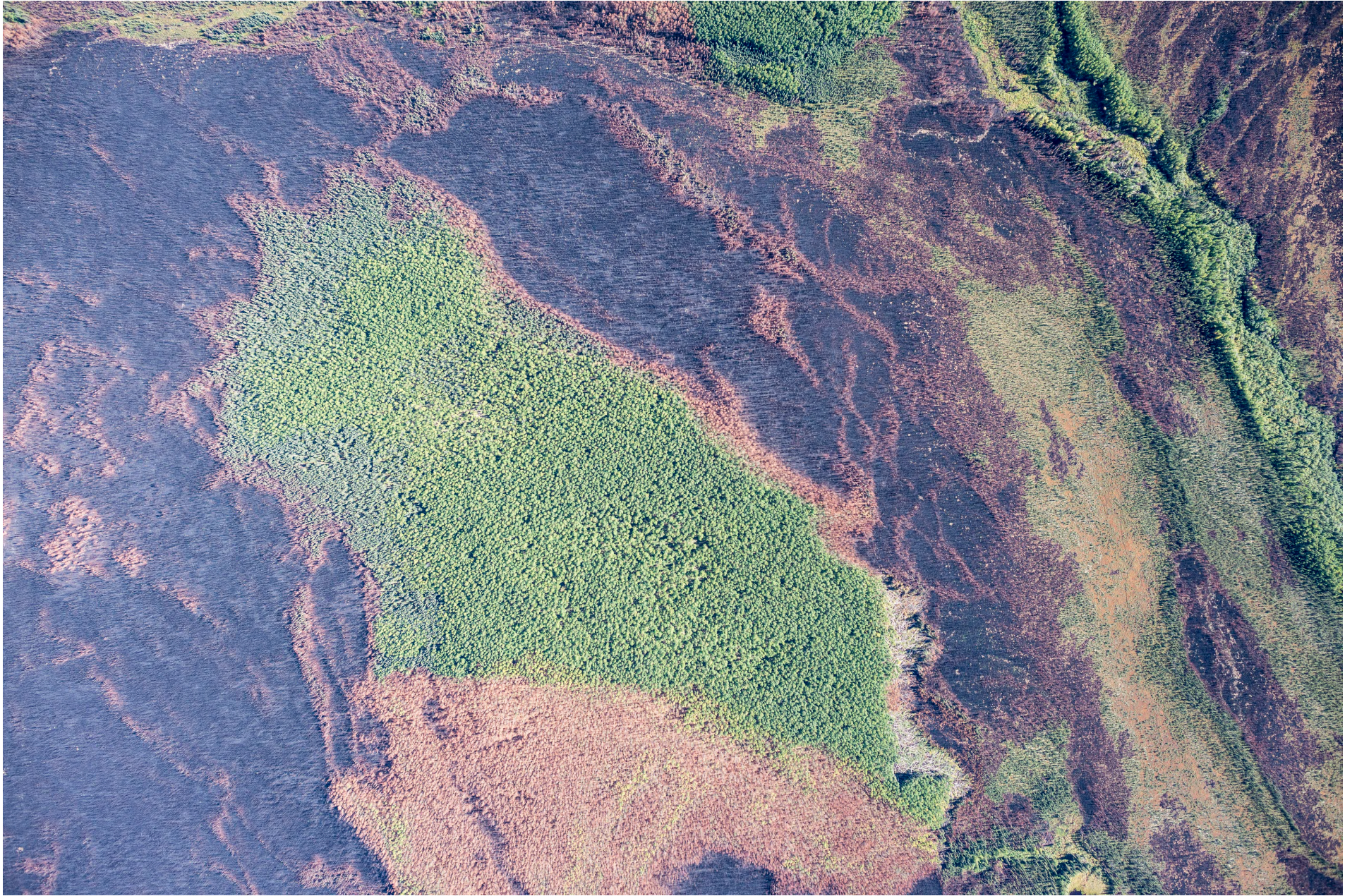
Nolan 2013: Example Photogrammetry Results

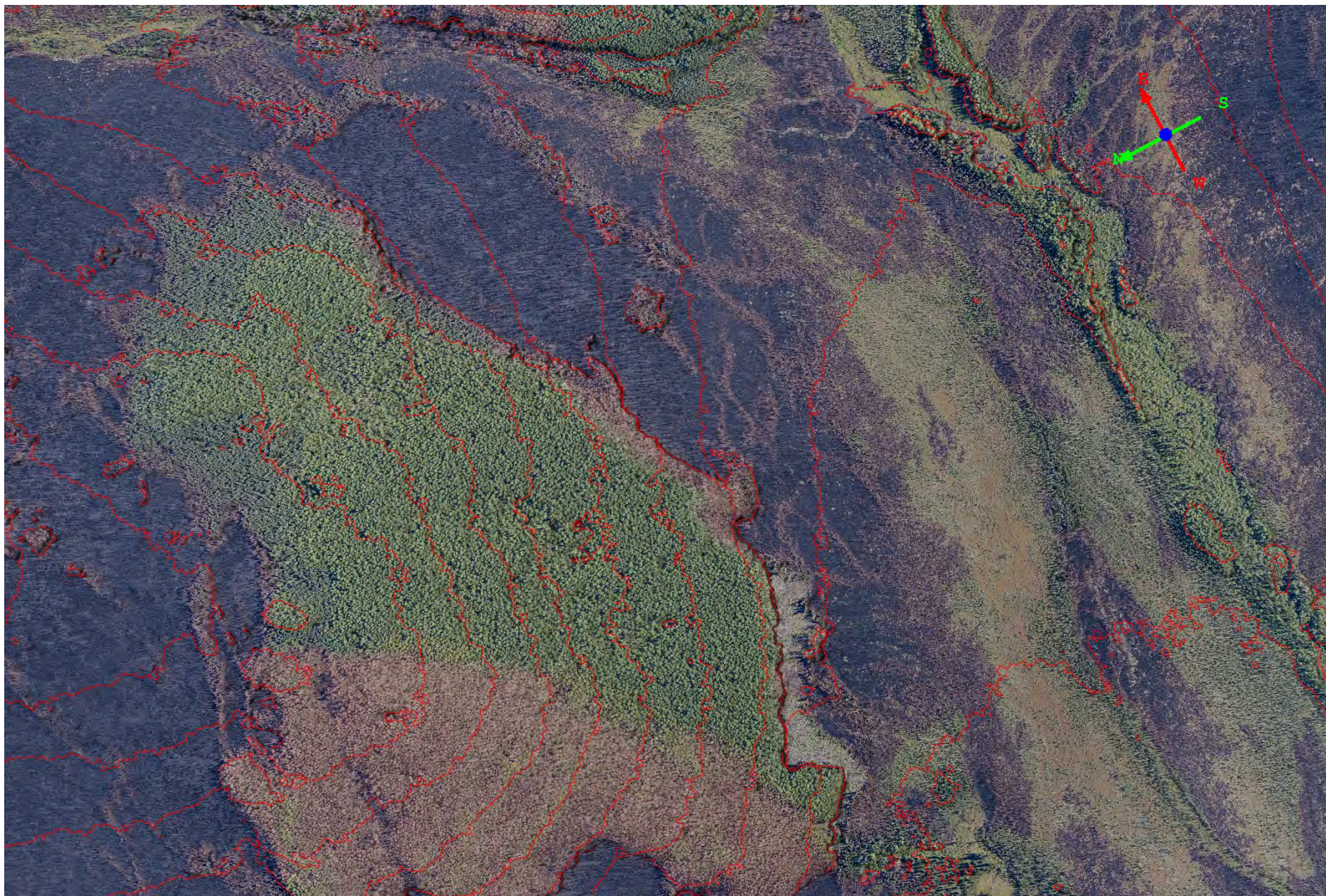


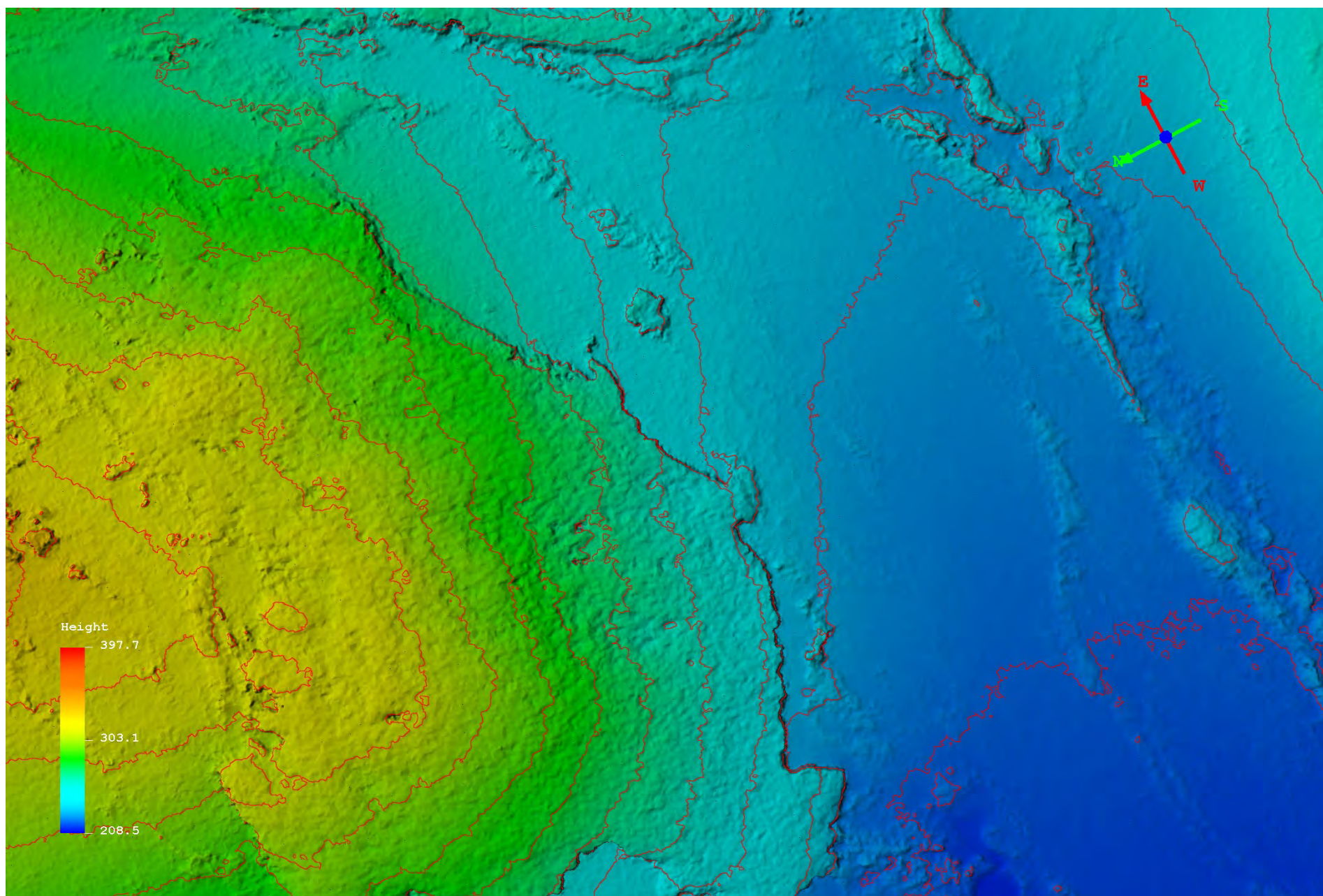


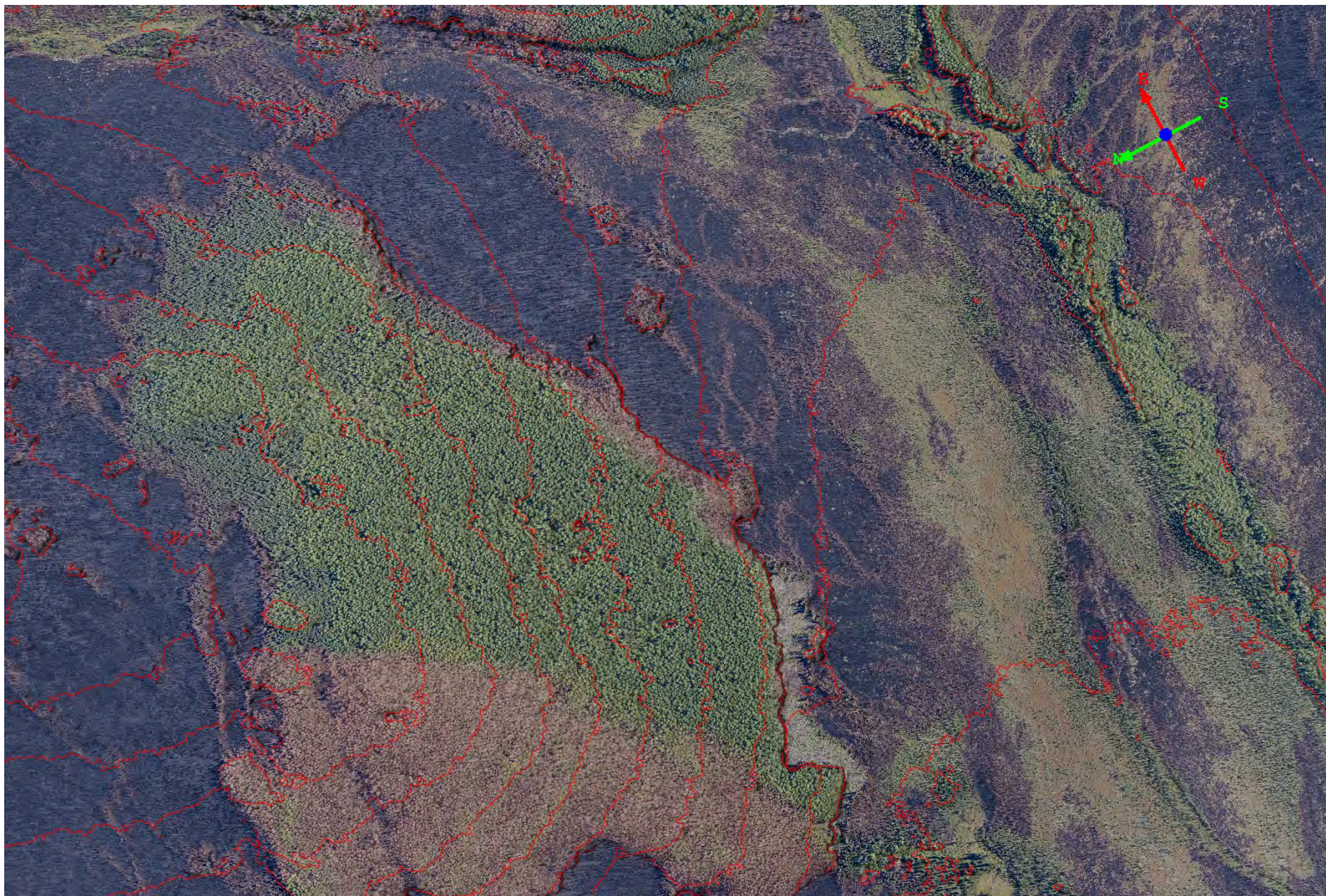


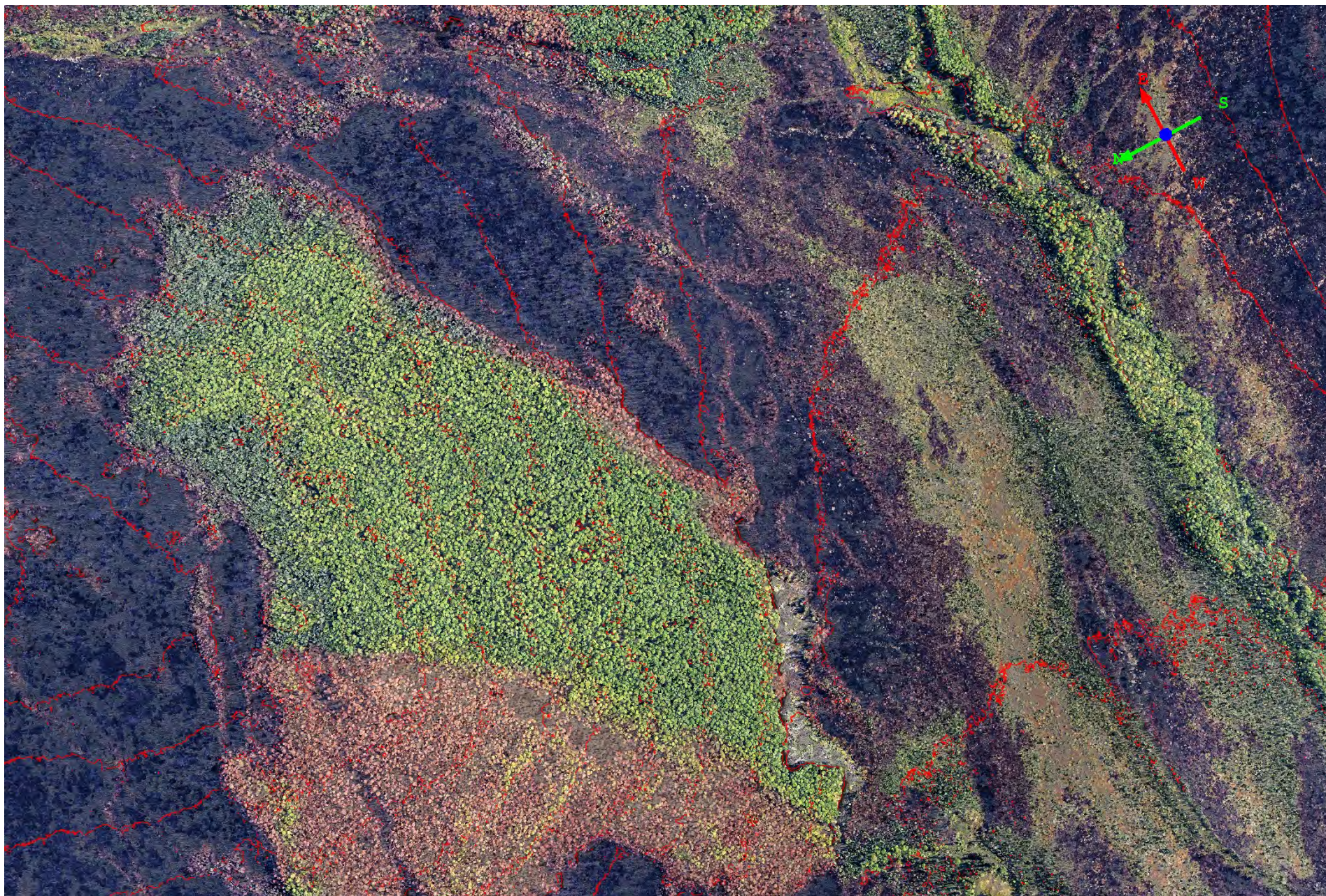




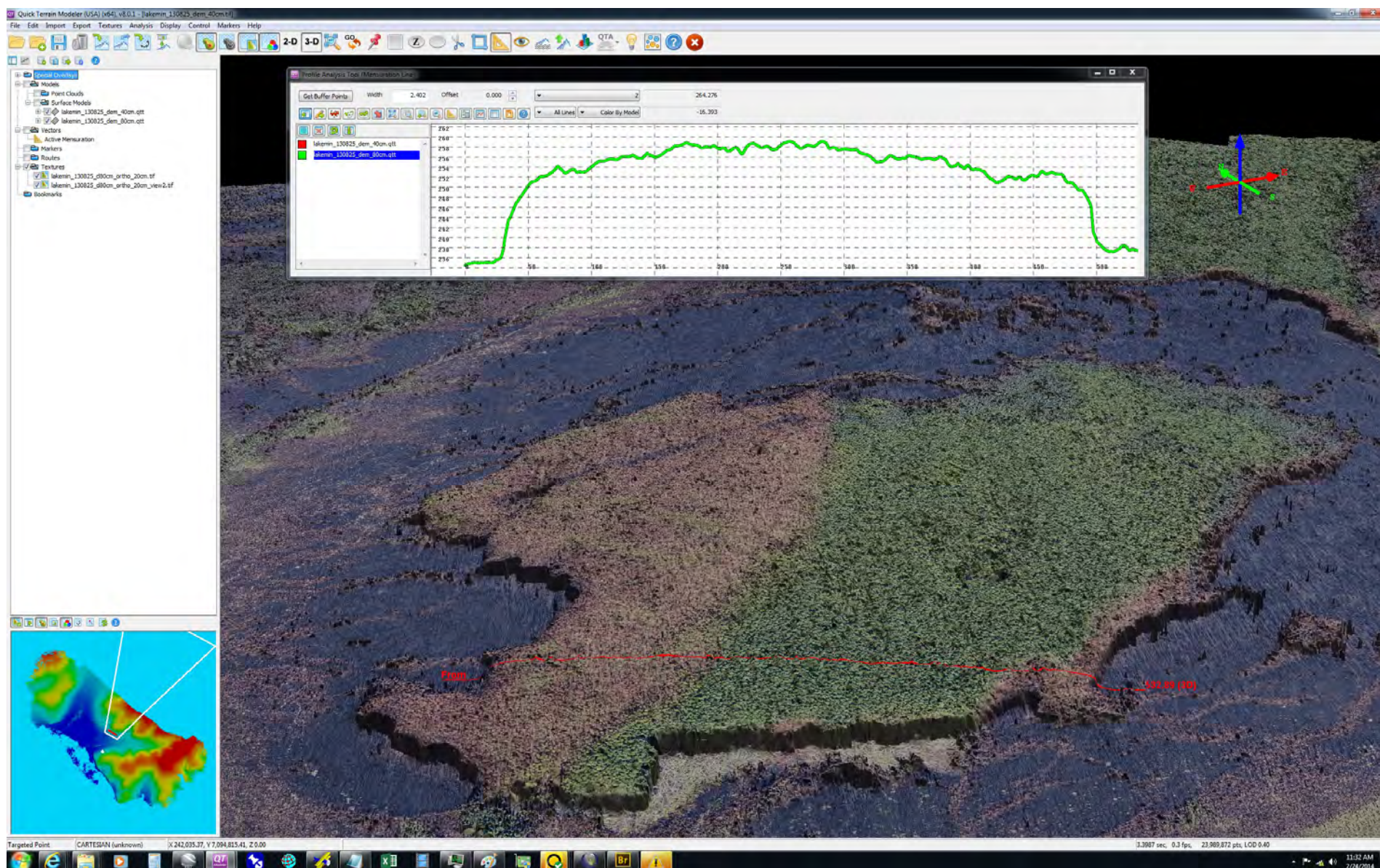


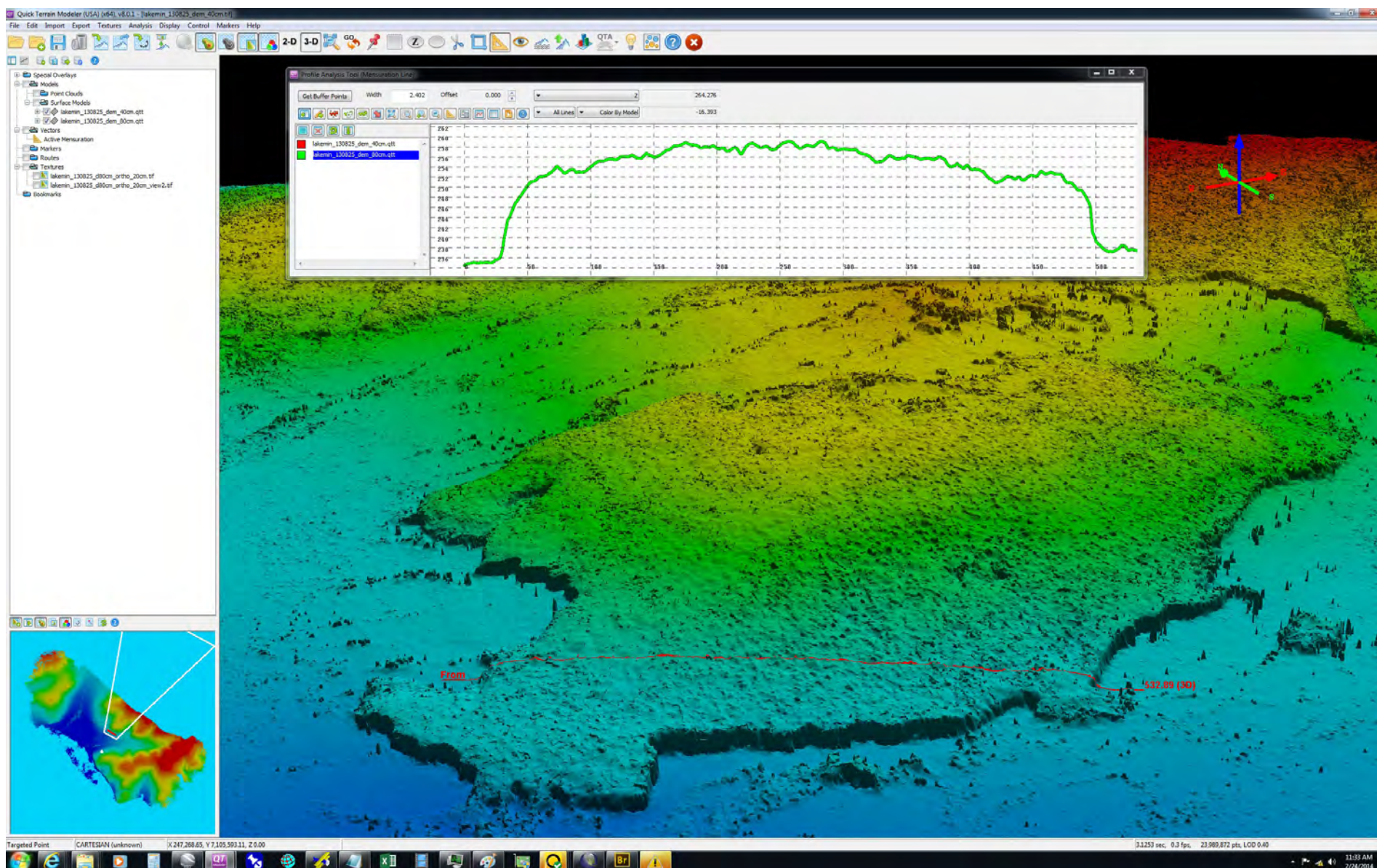


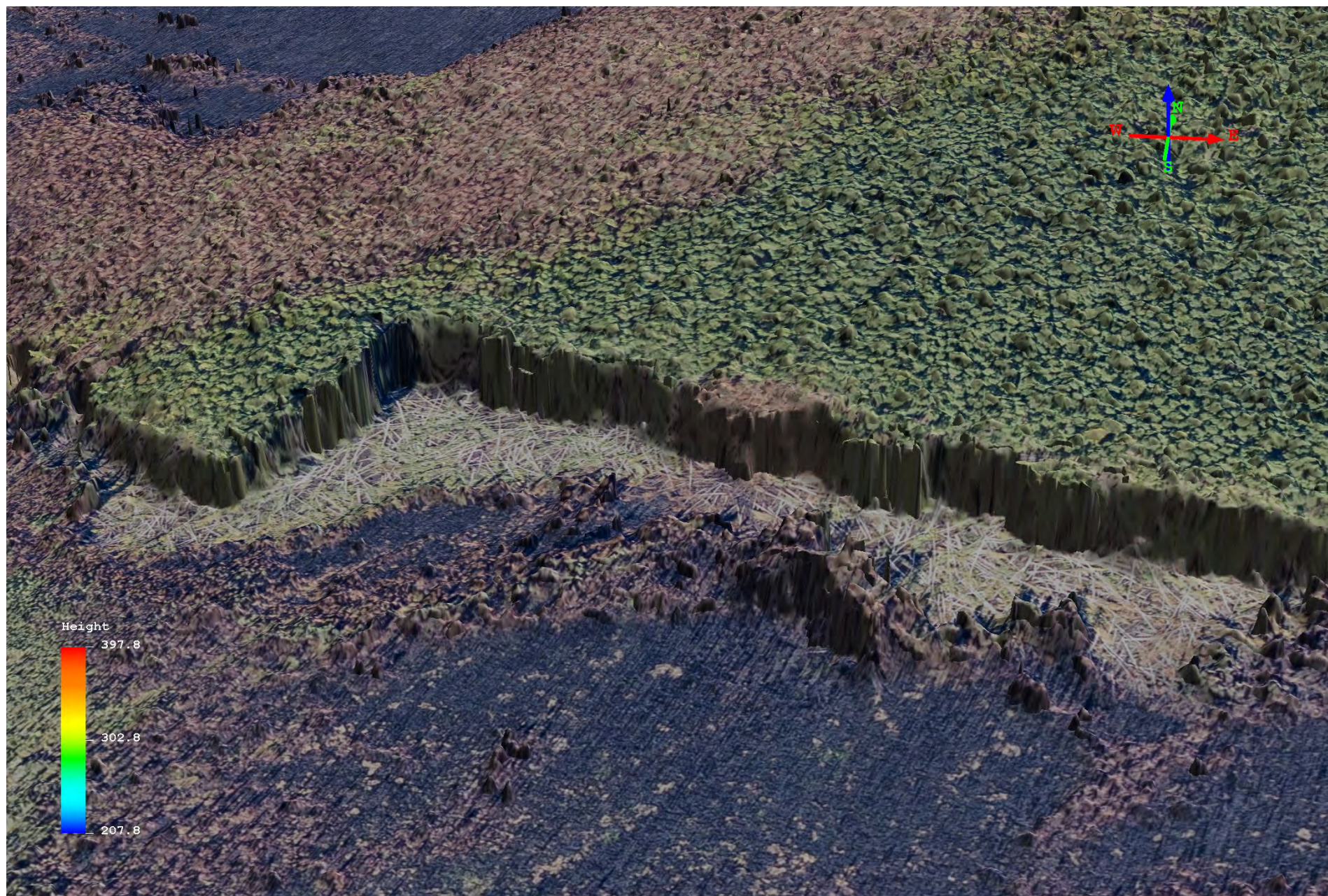


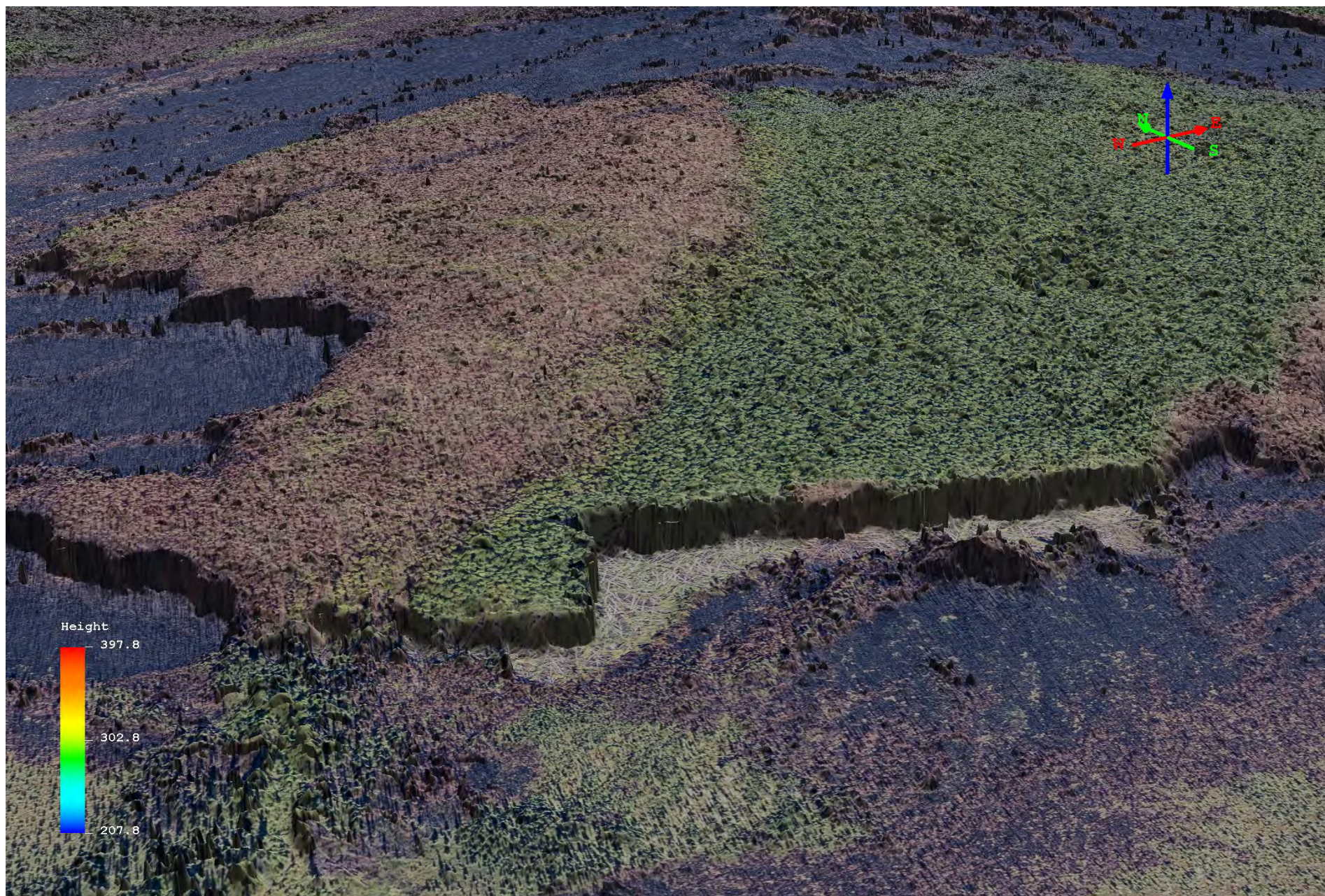


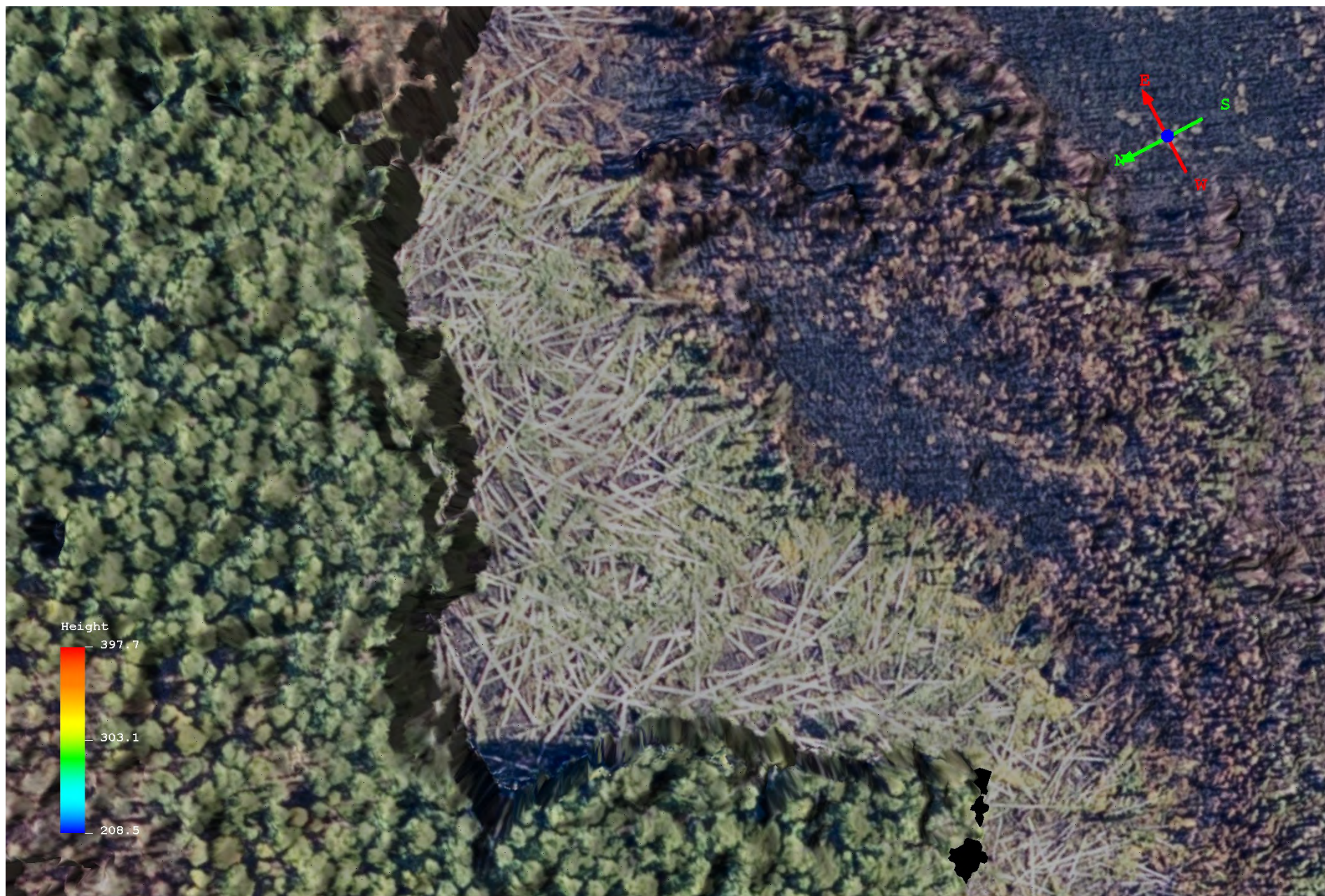




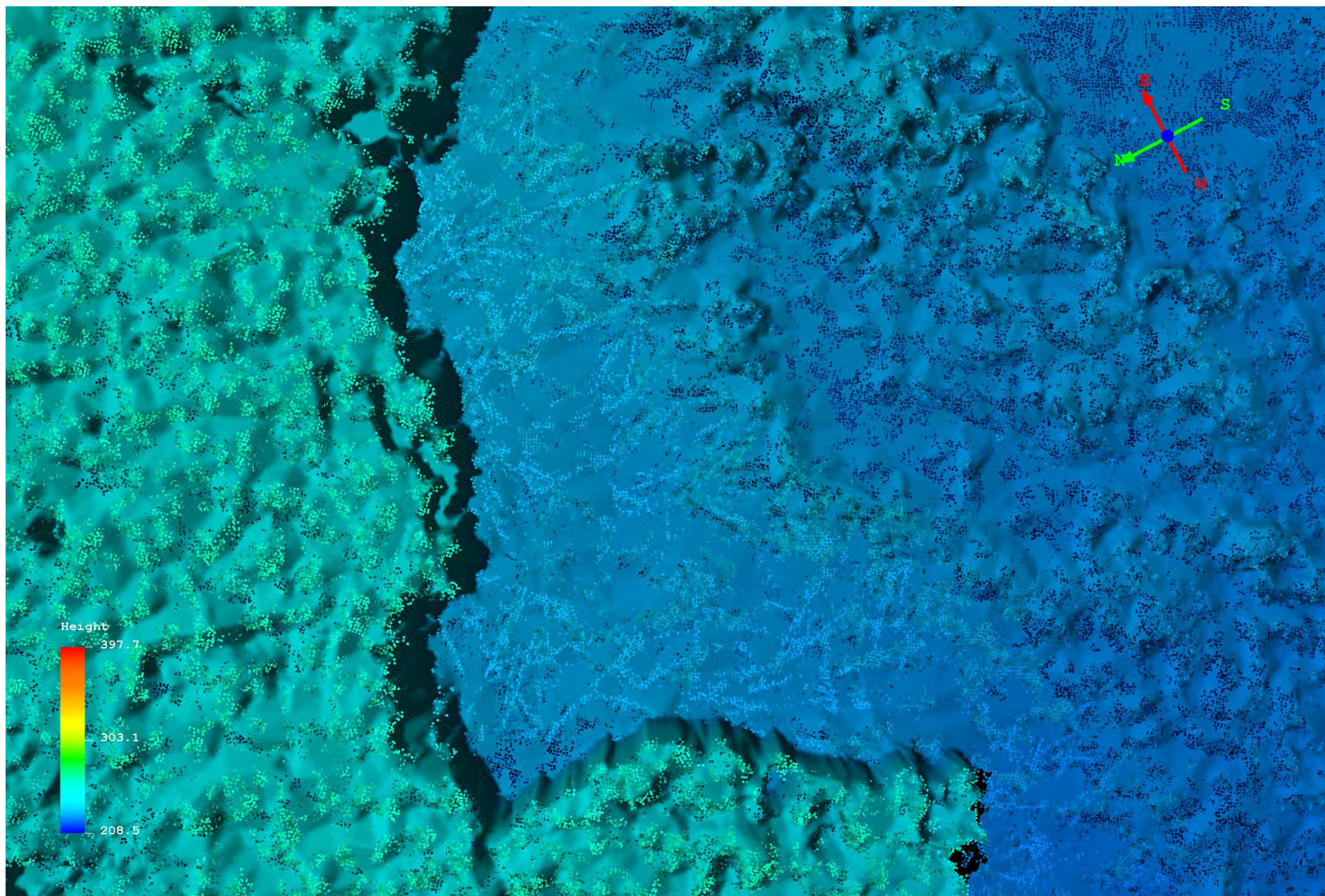






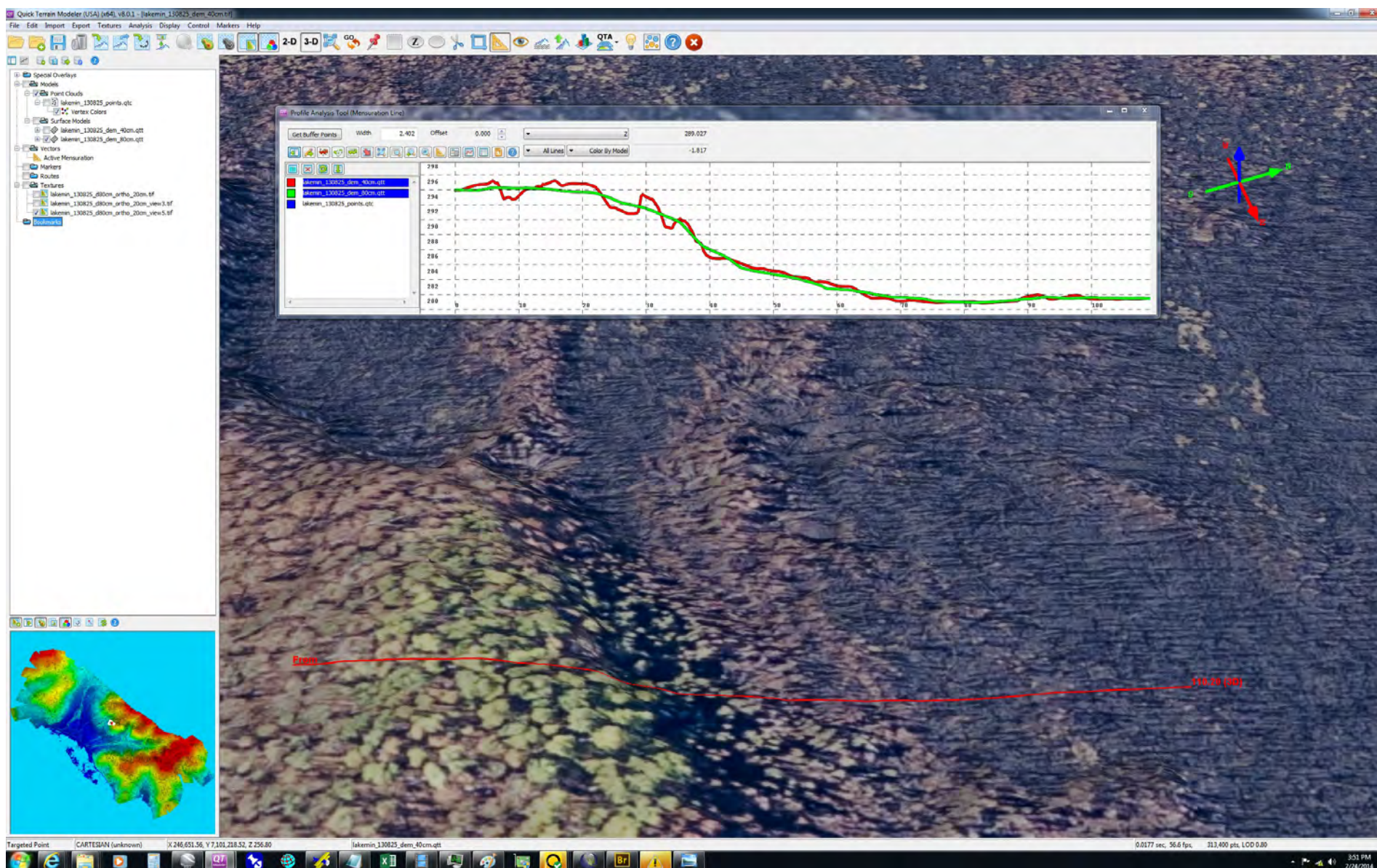


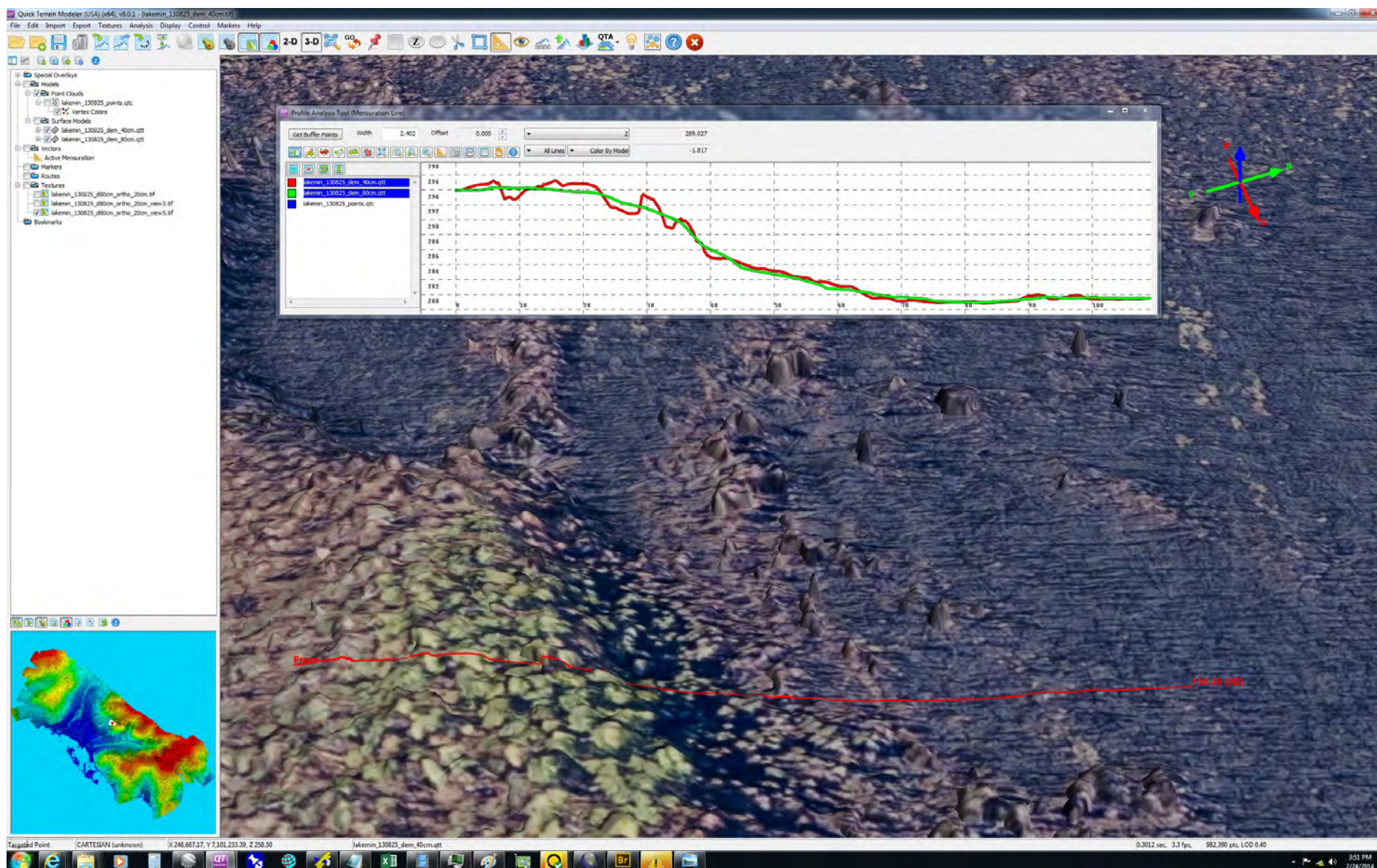


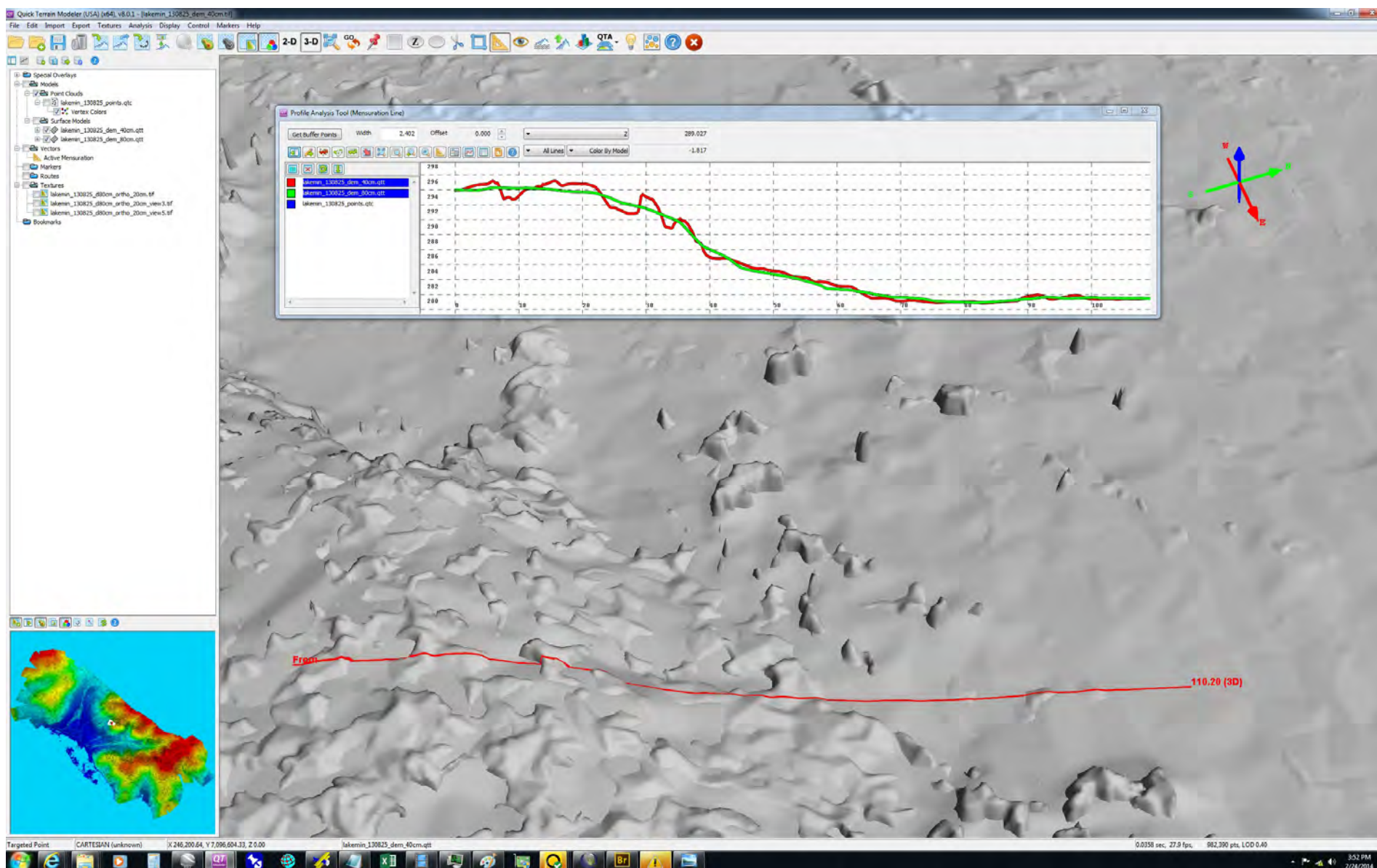






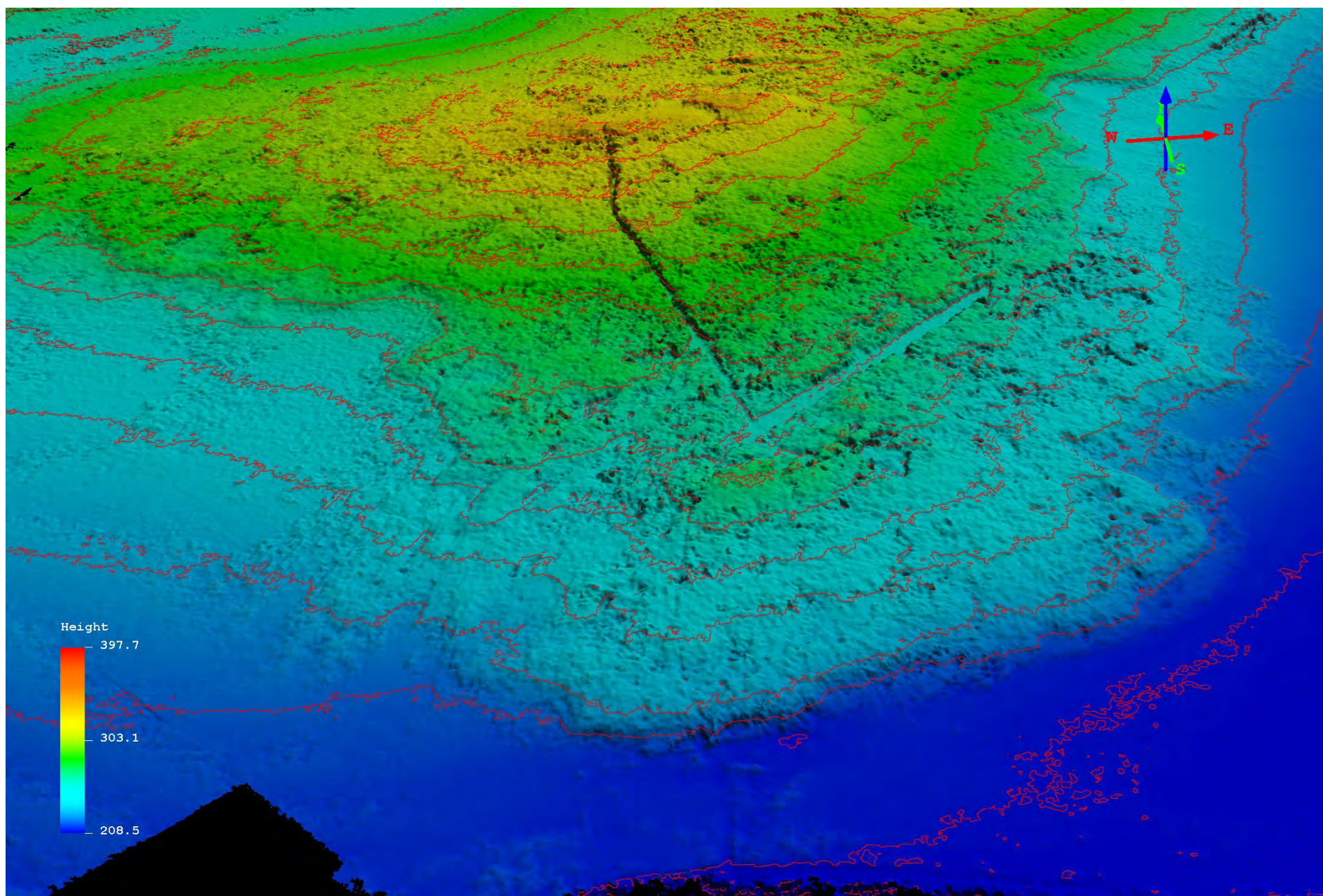


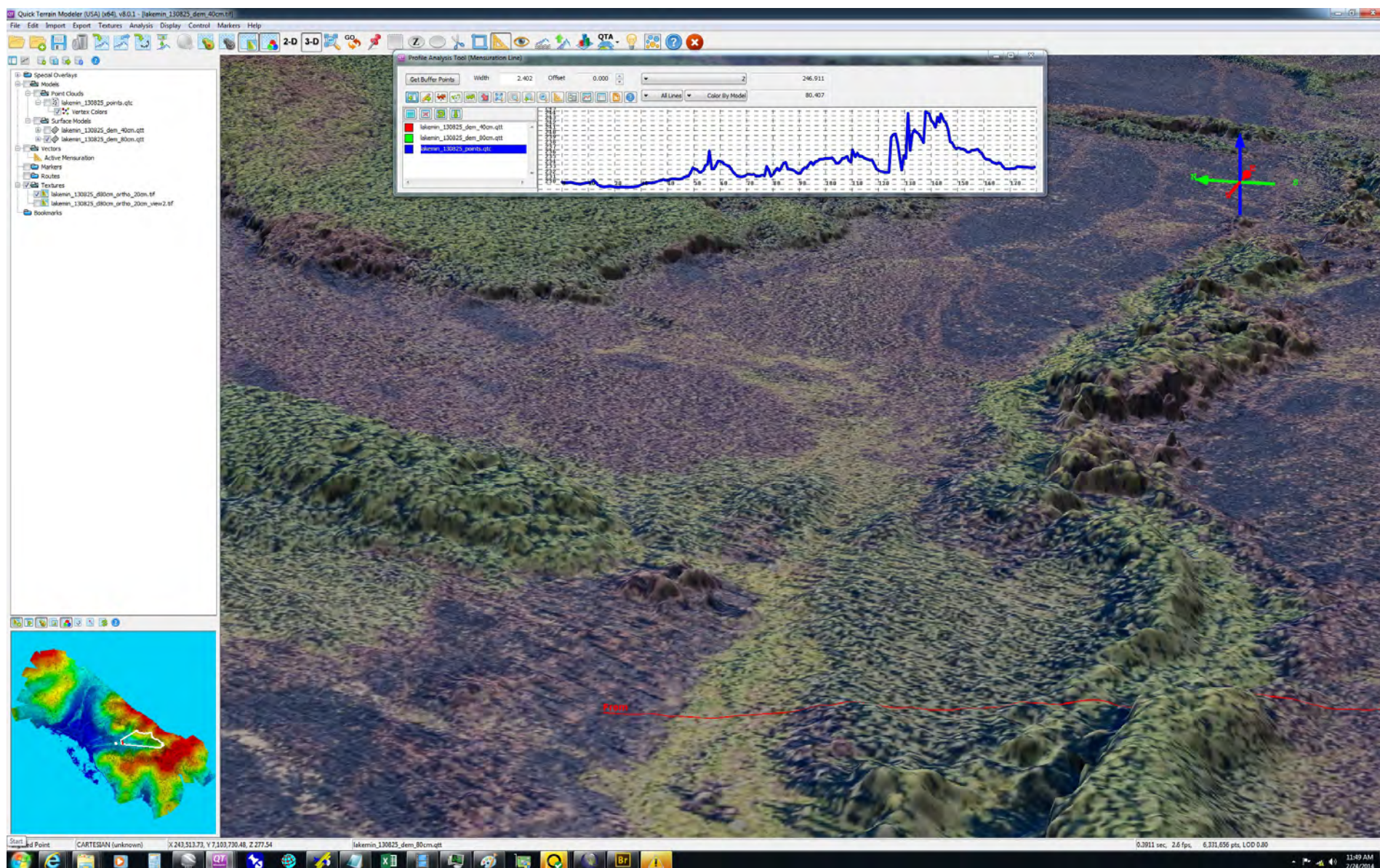


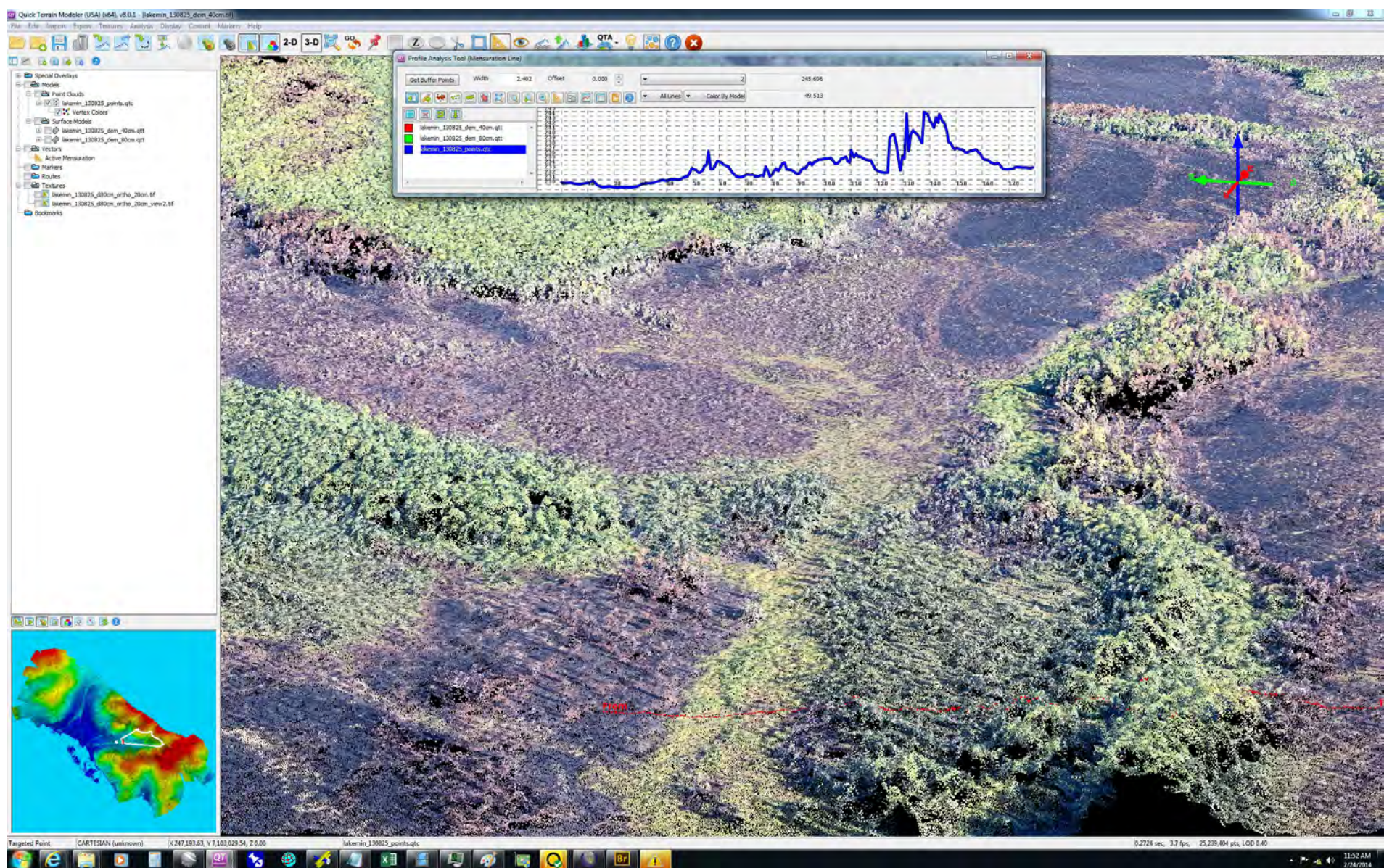


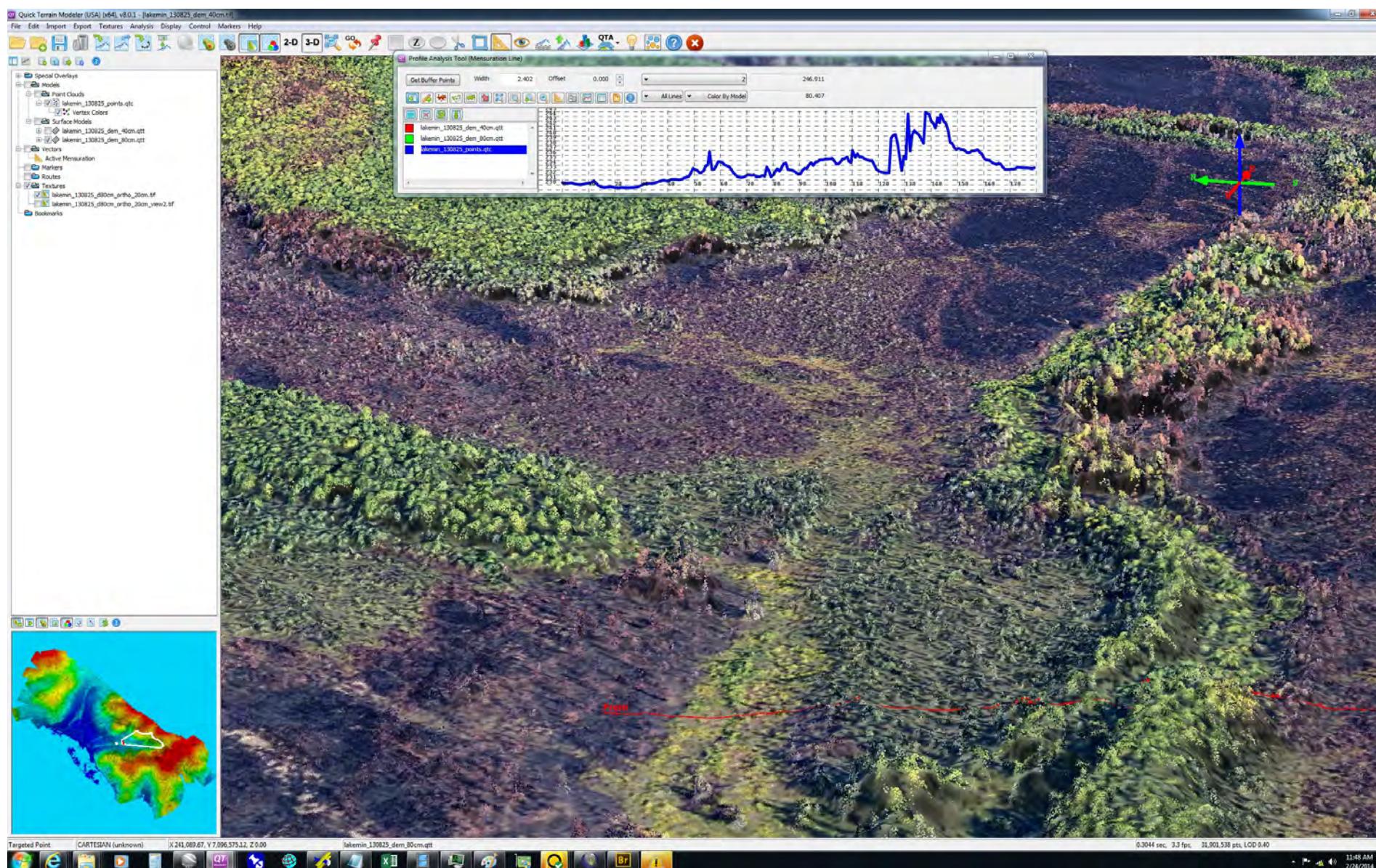


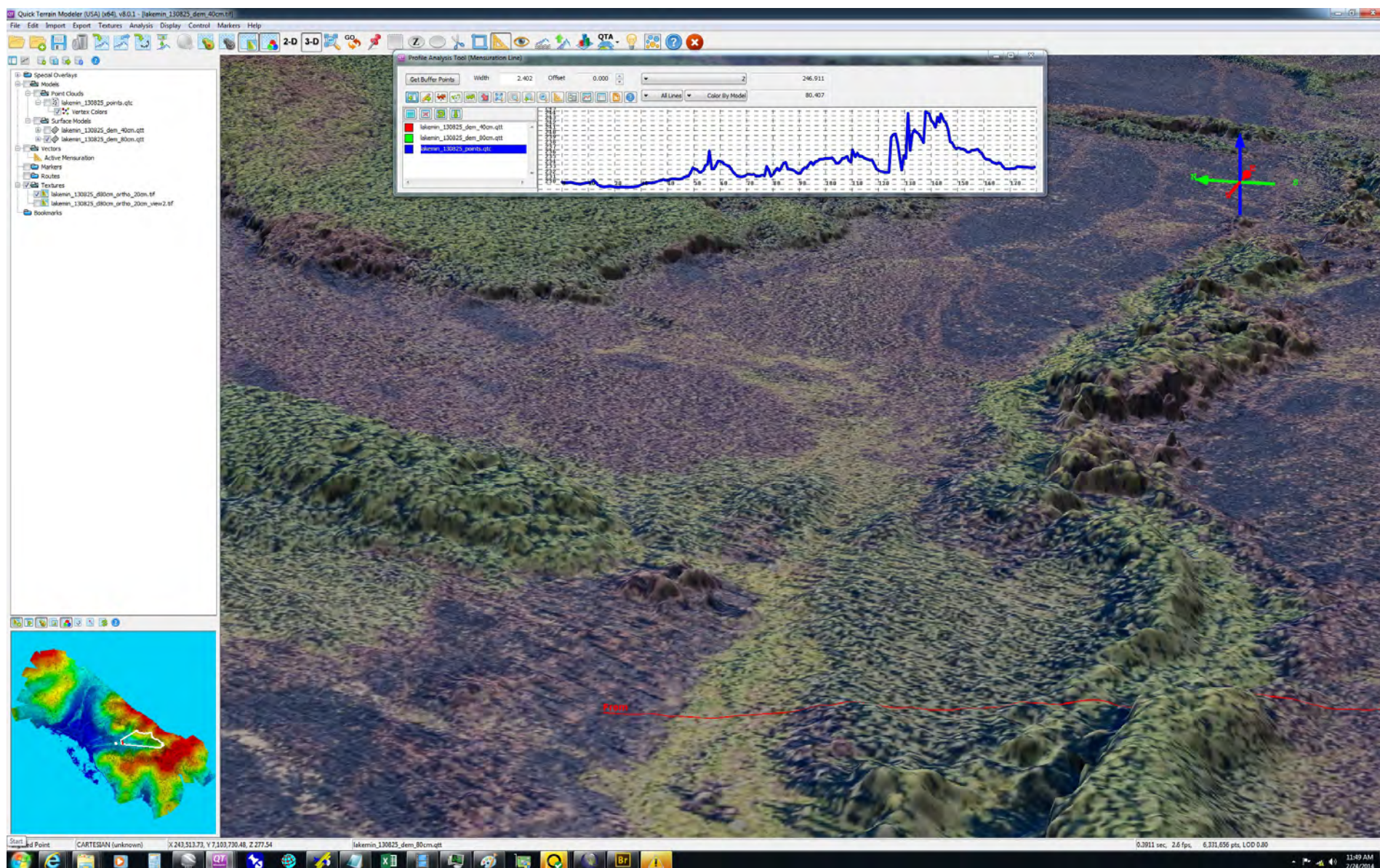


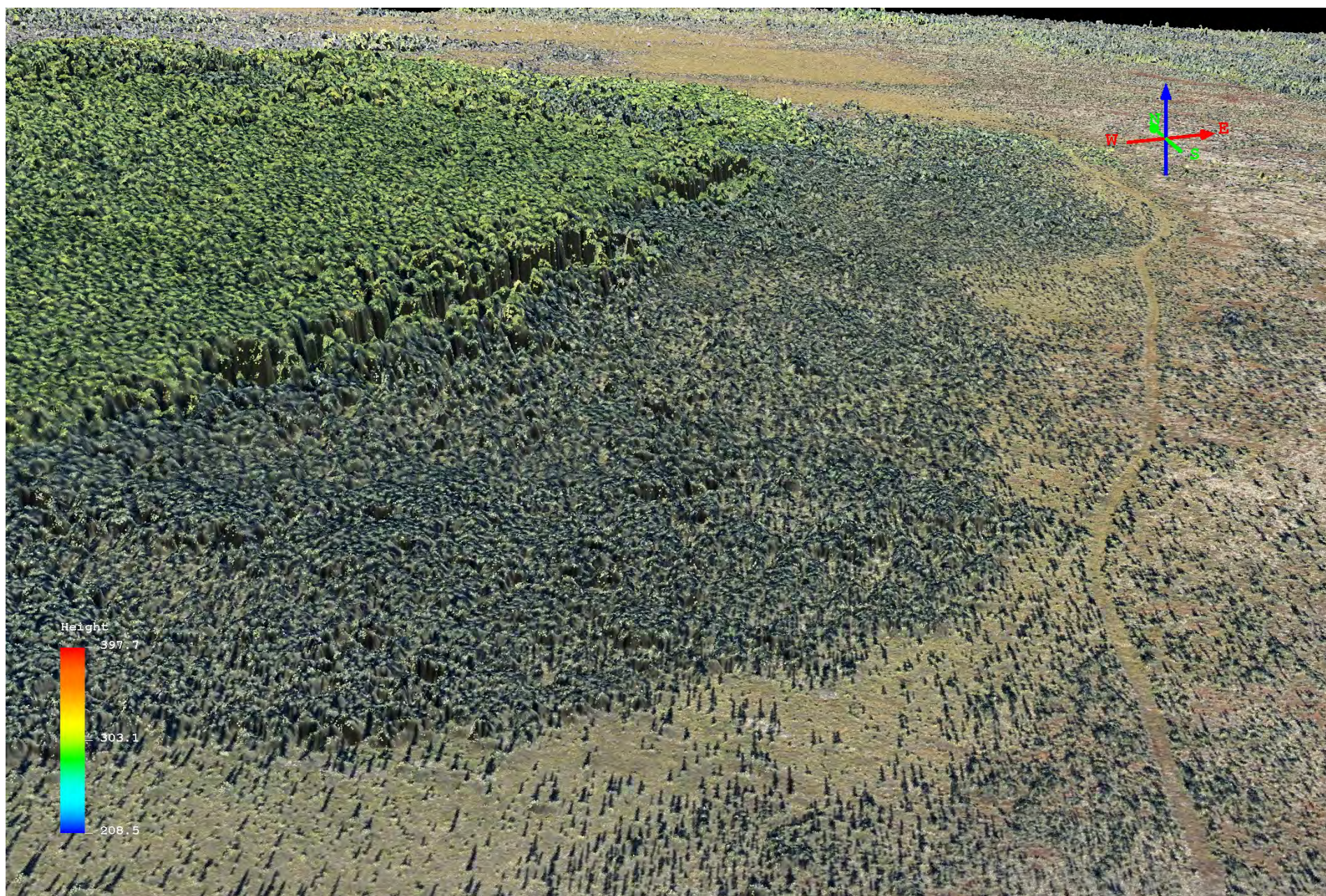




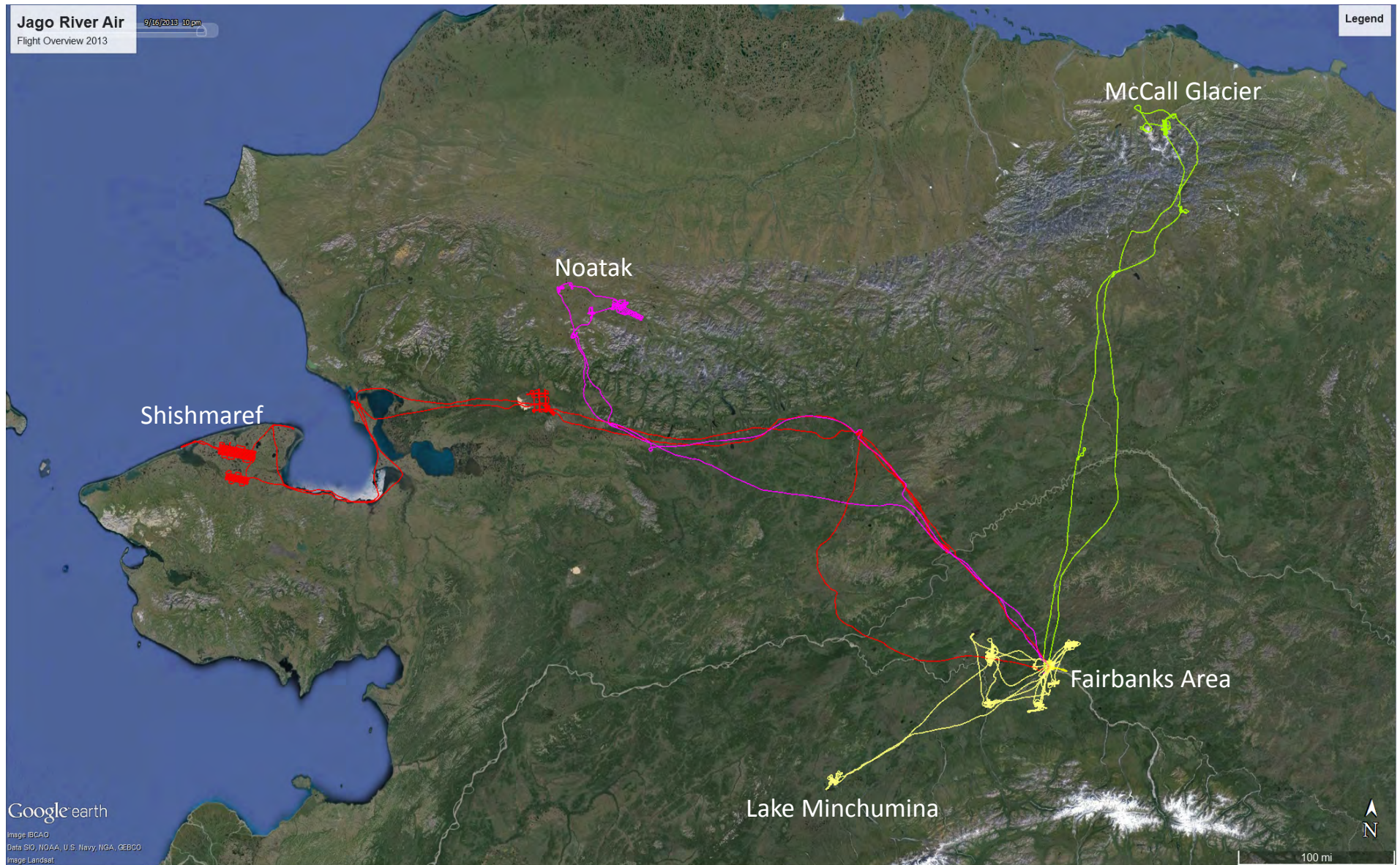








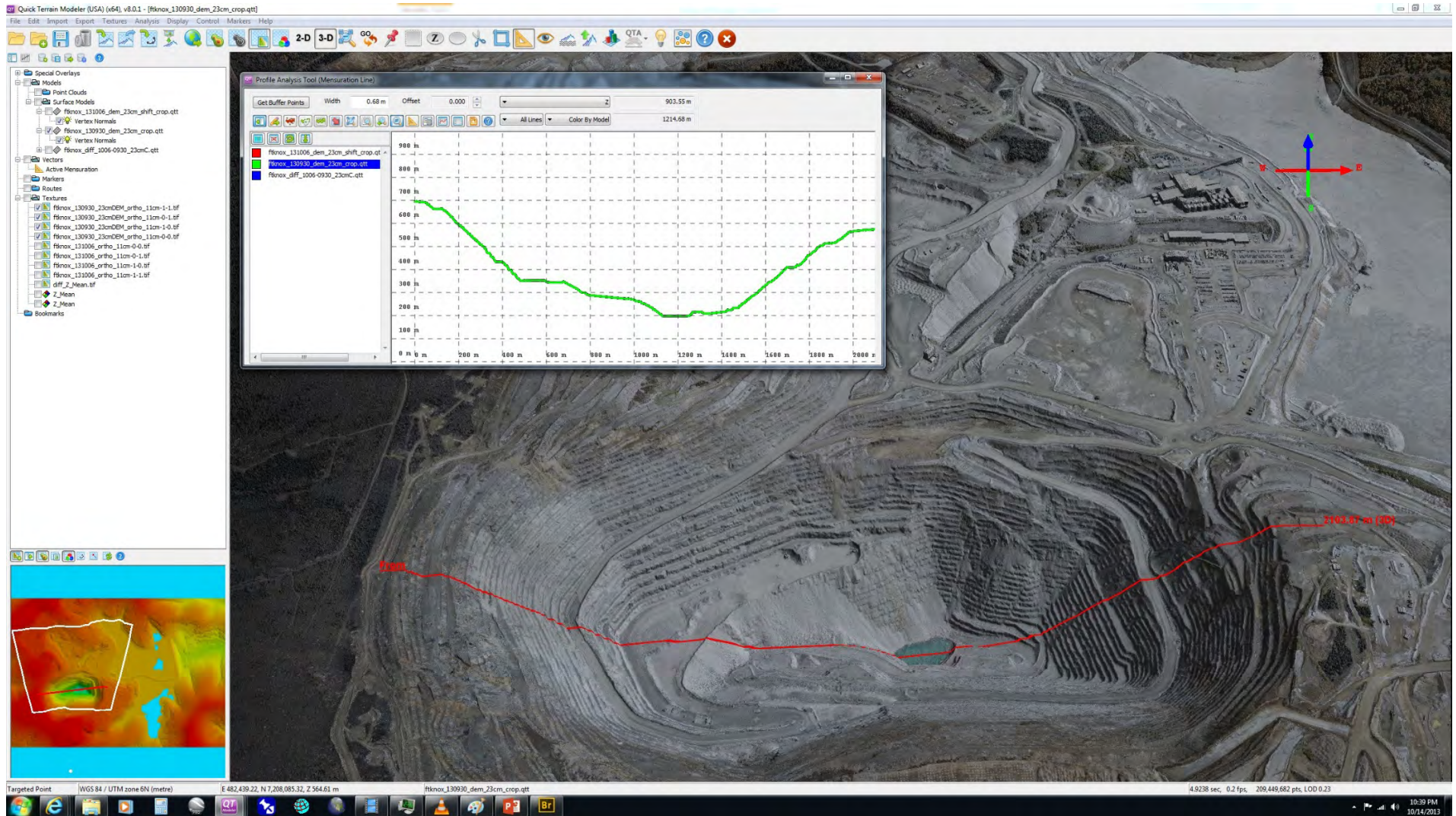
2013 Scientific Flights



I flew these missions in September and October of 2013.

Nolan 2013: Example Photogrammetry Results

A Quick Tour



The main pit dominates the landscape.

It is about 2100m at its widest and 900m at its deepest, as indicated by the graph and associated red line across the pit.

A Quick Tour



North of the pit are several large buildings, which is where the gold is presumably separated from the rock.

Blasting and Removal Operations



A close-up of drilling operations to prepare the next blast site in Phase 7 West.

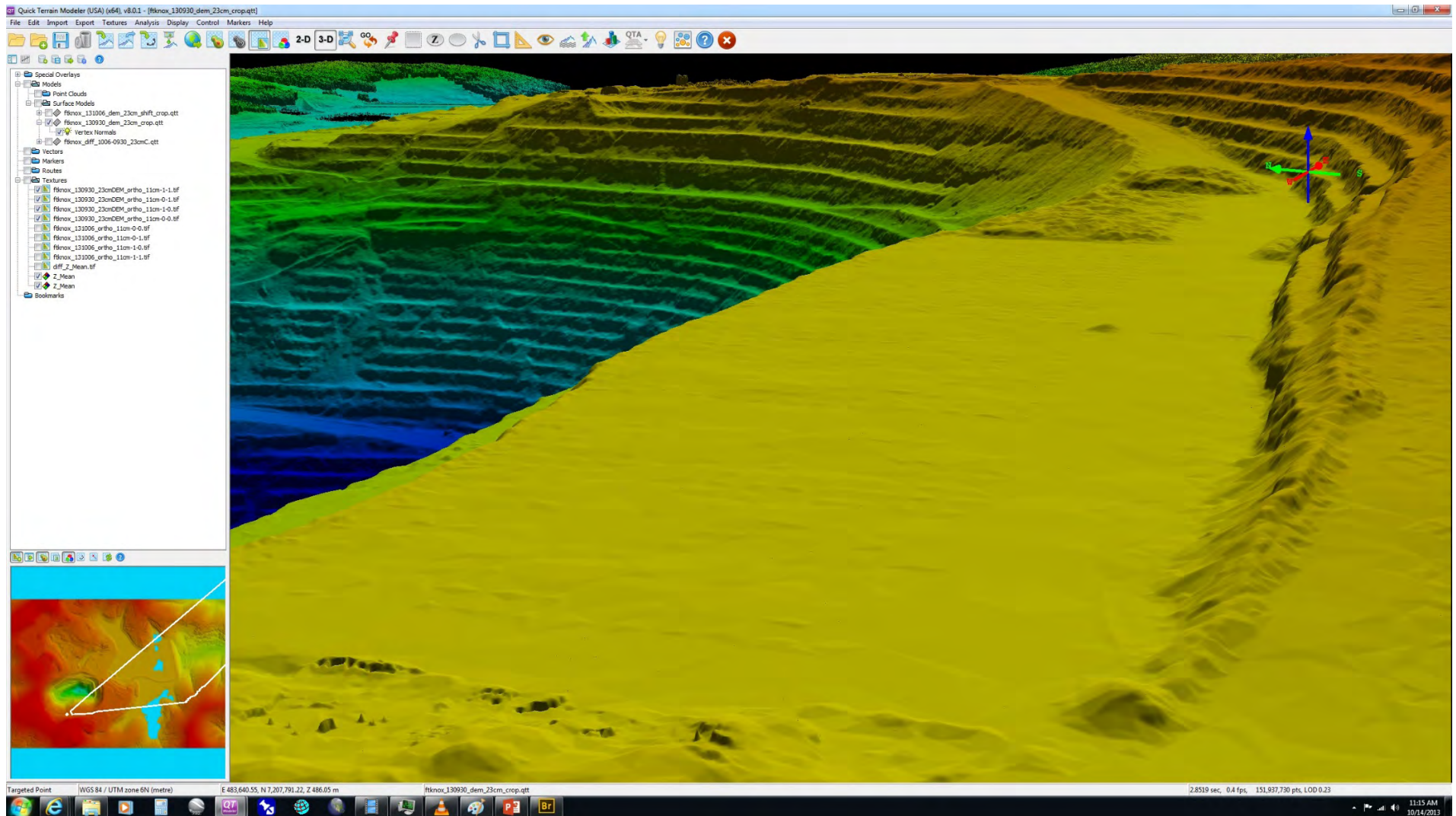
Four drill trucks are creating a grid of blast holes (surmised direction of operation shown by arrows), while a supervisor looks on. Note the increased shot density near the cliff edge, presumably to blow it out first.

Blasting and Removal Operations



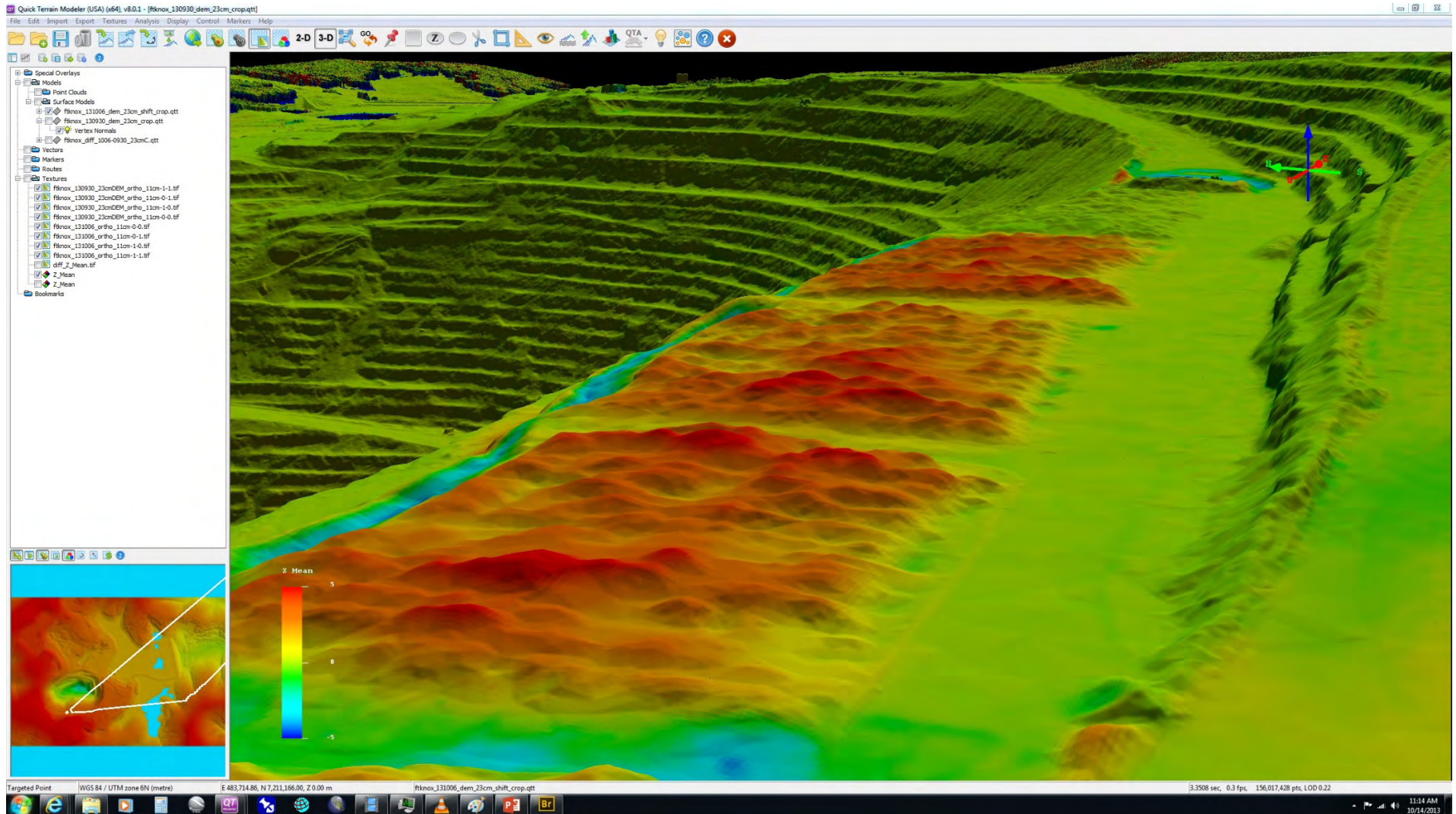
A close-up of the next blast site with drilling apparently completed. An older blast site is behind it and is in the process of being excavated.

Blasting and Removal Operations



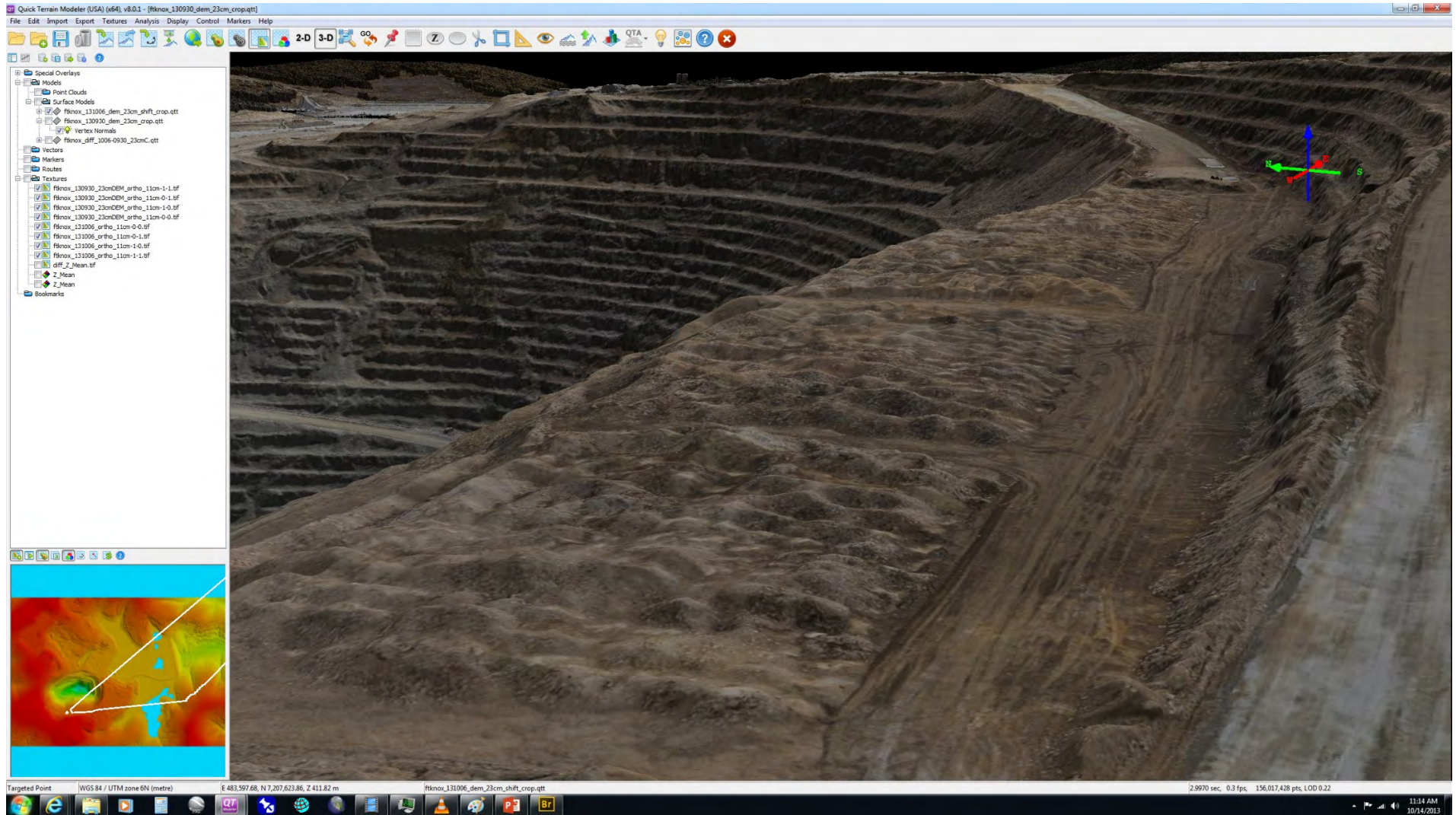
Each blast site is graded fairly level and smooth before drilling proceeds.

Blasting and Removal Operations



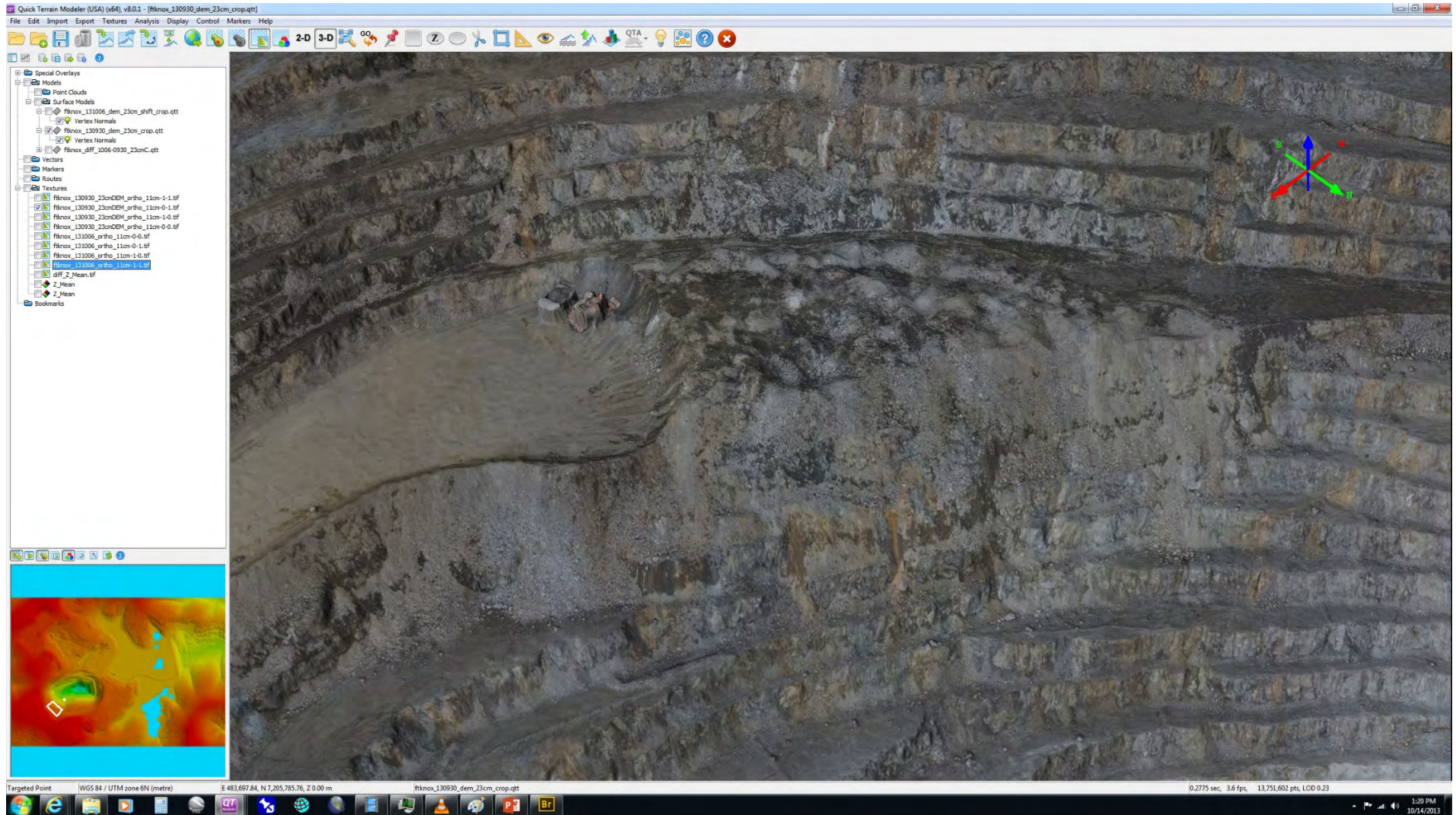
During the blast, the front face is blown forwards and the remainder lifted upwards. The resulting jumble doesn't fit back into place, so sits 3-5 meters above the original grade, loosening rock about that deep below.

Blasting and Removal Operations



Cleanup begins by pushing a road through behind it so that the excavators and dump trucks can easily access it.
By now most of the old blast site behind it has been cleared out.

Volume Change Measurements



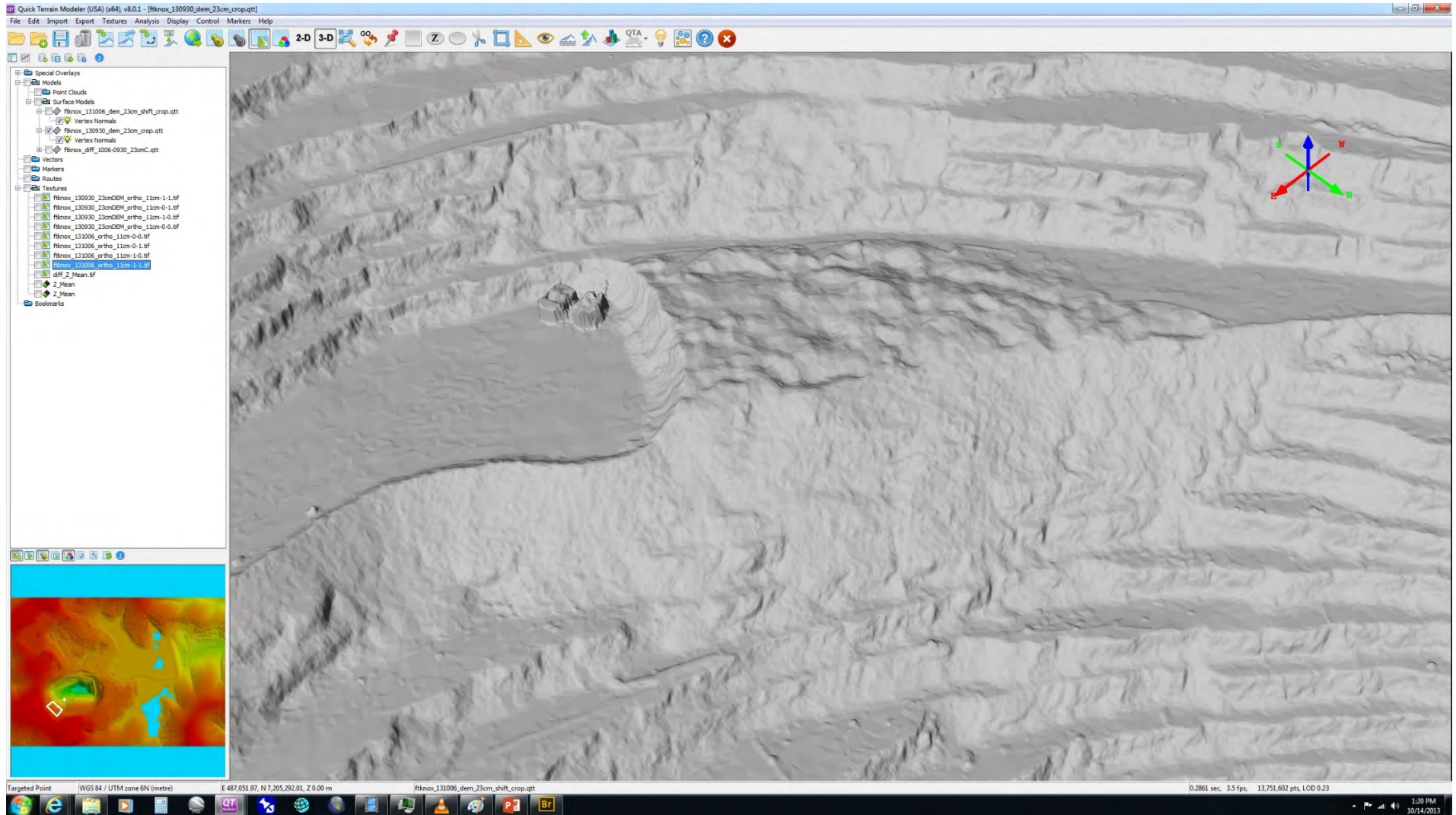
On September 30th, trucks were still removing recently blasted rock. Sometime during the next week, a small slide occurred in that area. The amount of extracted rock is 109,000 m³. Not much of the slide had not yet been cleared by October 9th, as measurements show a loss of 2400m³ and a gain of 2900 m³, balancing to within 15%.

10/13/2013

Nolan: Ft Knox Mine Analysis

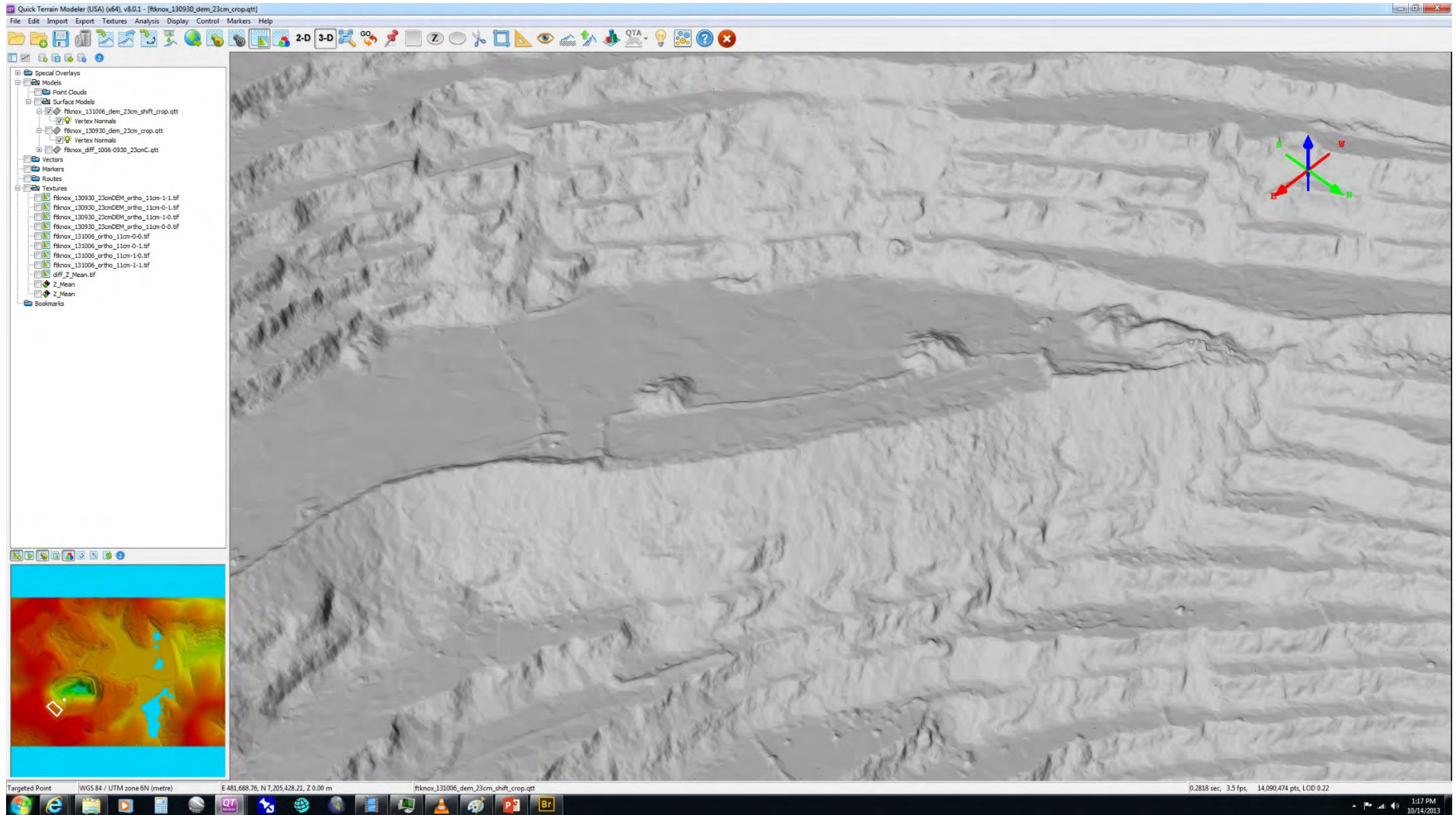
67

Volume Change Measurements



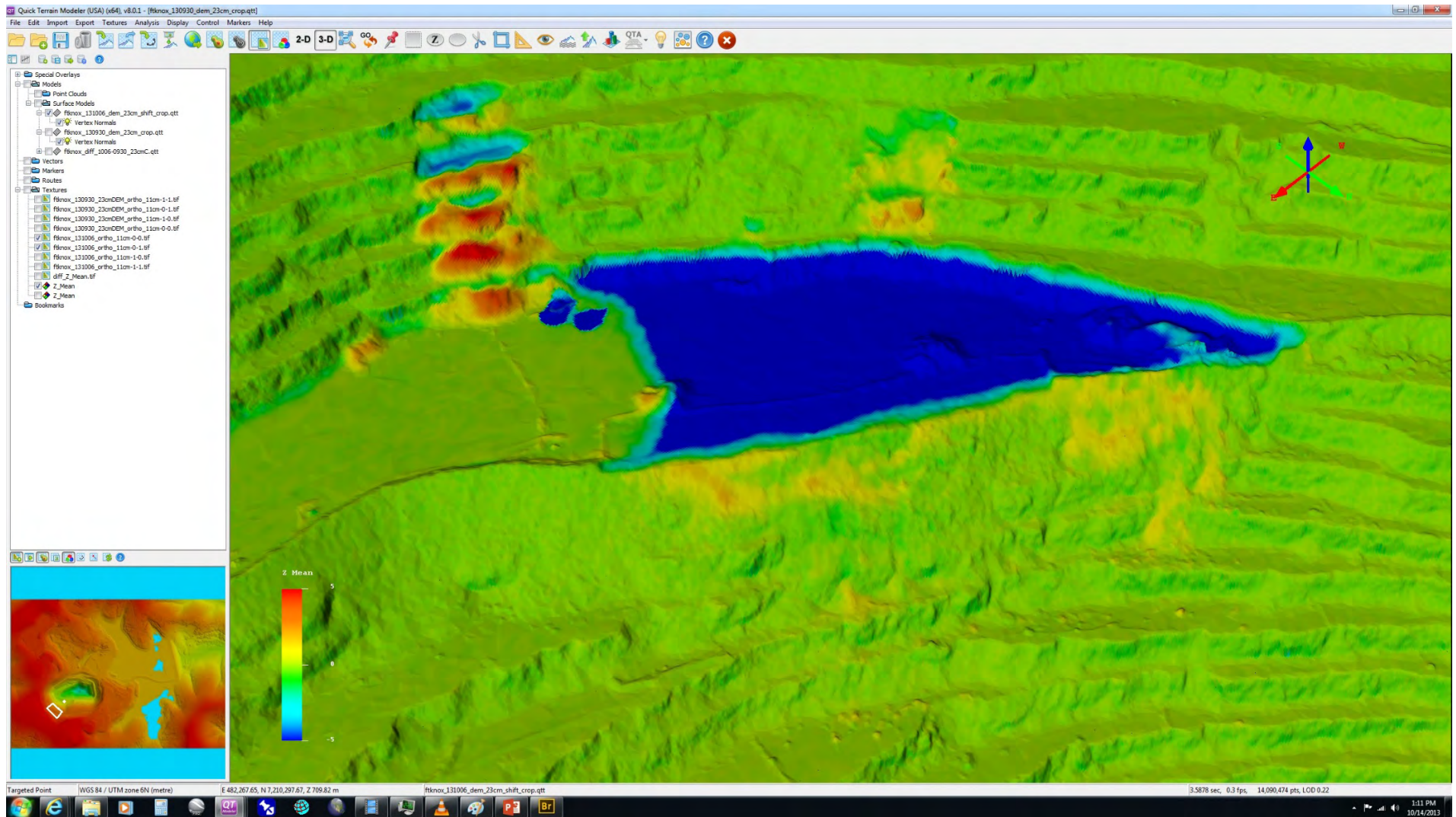
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Volume Change Measurements



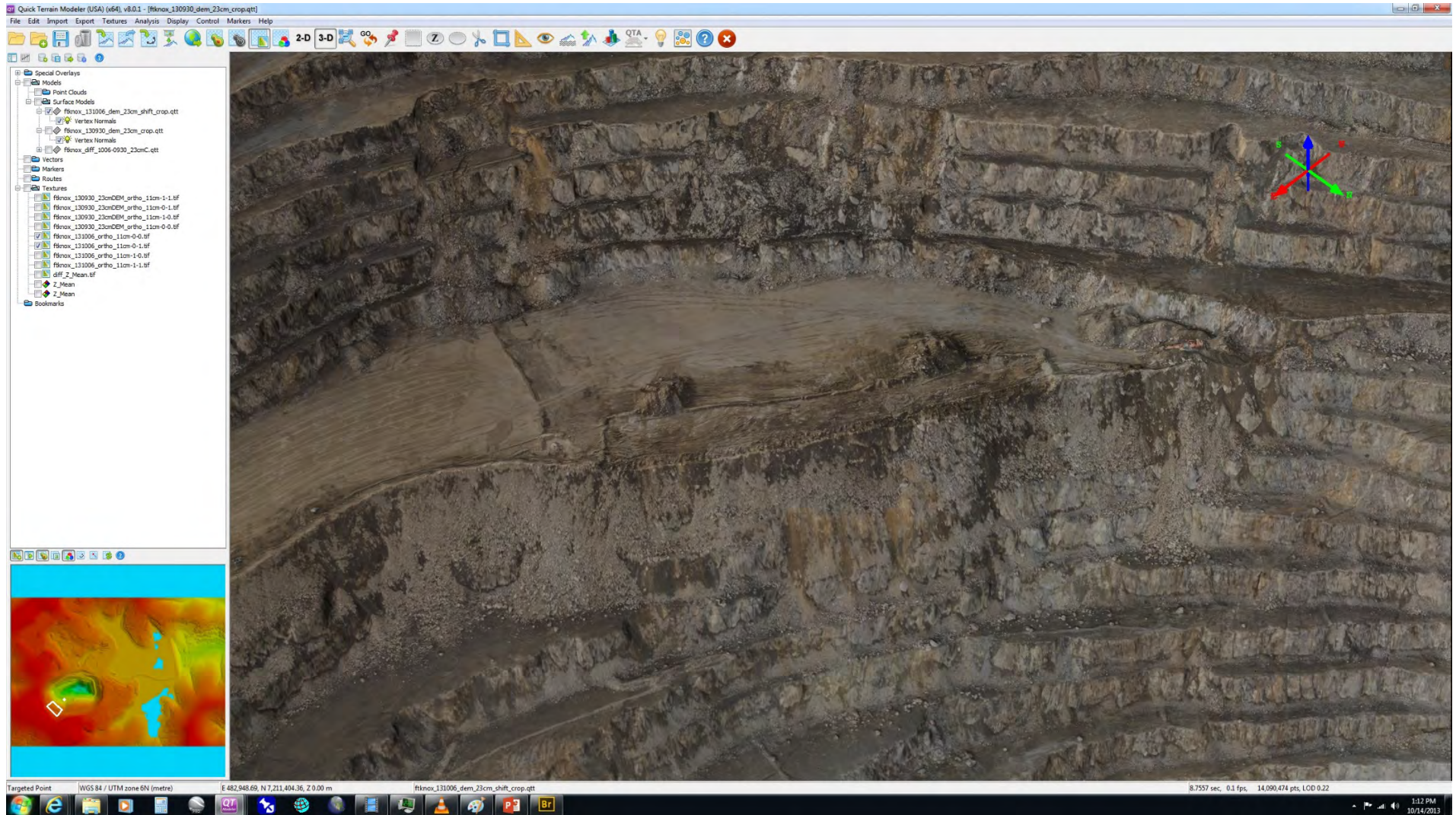
On September 30th, trucks were still removing recently blasted rock. Sometime during the next week, a small slide occurred in that area. The amount of extracted rock is 109,000 m³. Not much of the slide had not yet been cleared by October 9th, and measurements show a loss of 2400m³ and a gain of 2900 m³, due to the density change.

Volume Change Measurements



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Volume Change Measurements



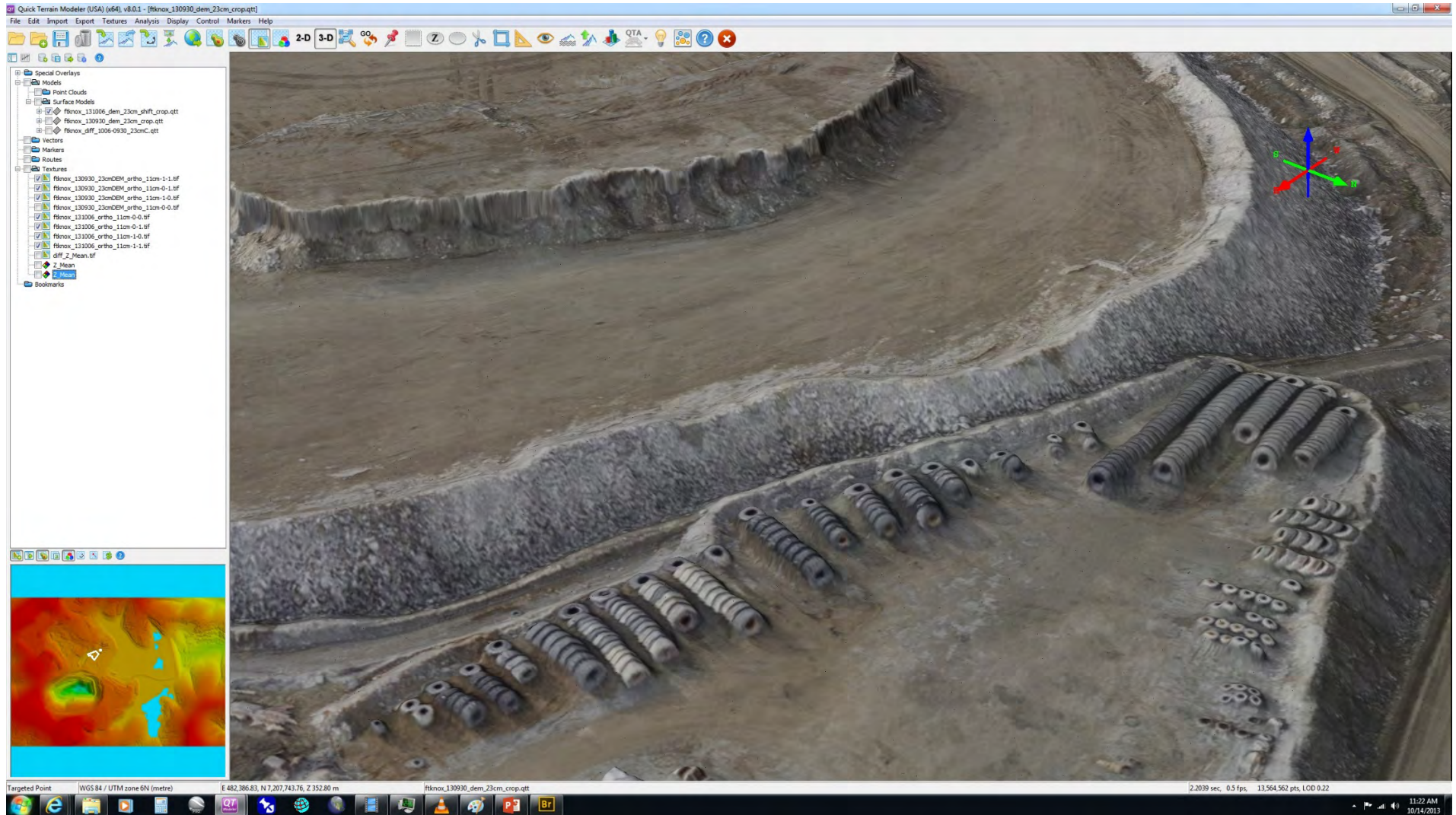
On September 30th, trucks were still removing recently blasted rock. Sometime during the next week, a small slide occurred in that area. The amount of extracted rock is 109,000 m³.

Spatial Resolution and Change Detection



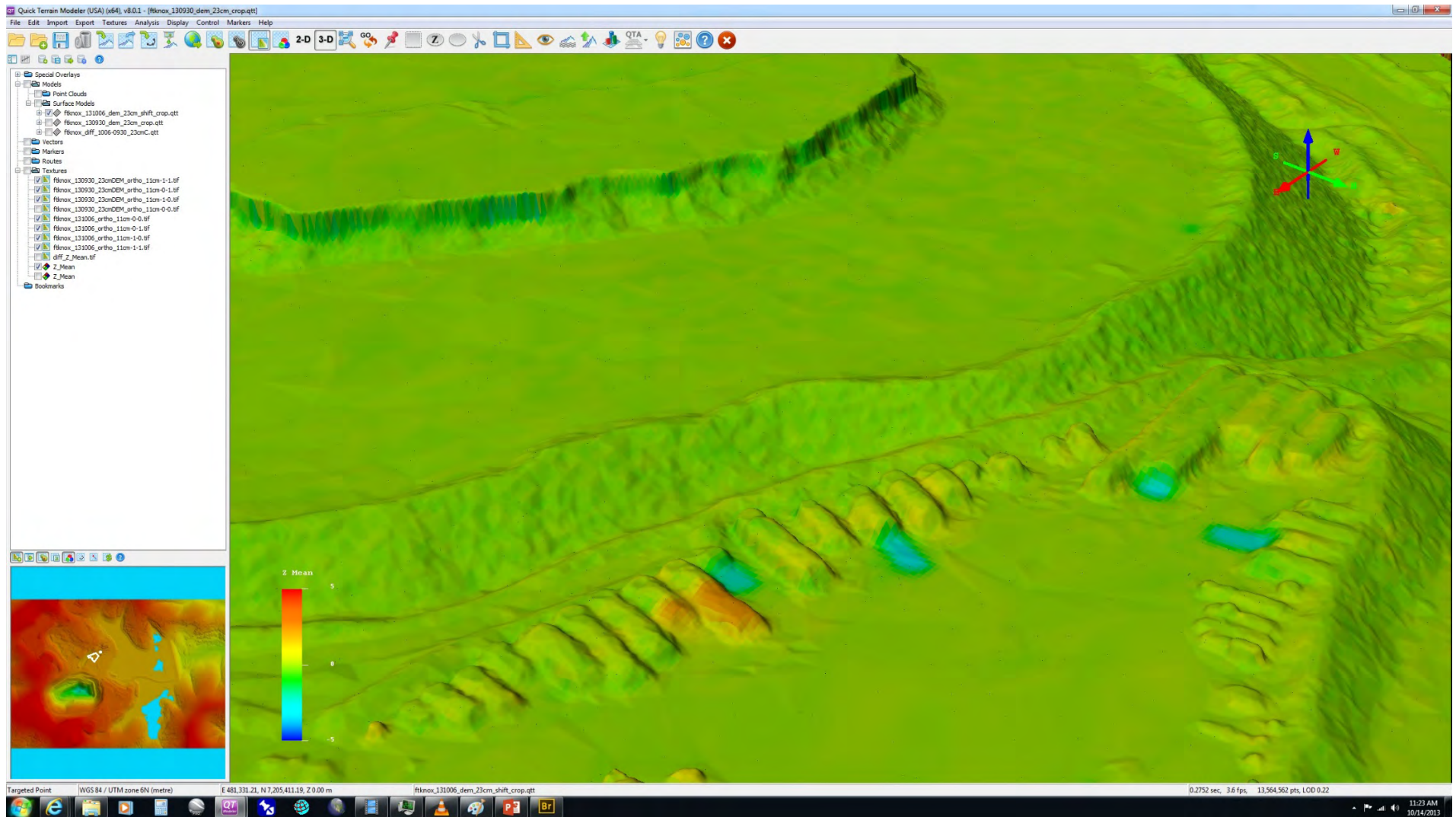
Near the processing plant, a tire storage yard exists.

Spatial Resolution and Change Detection



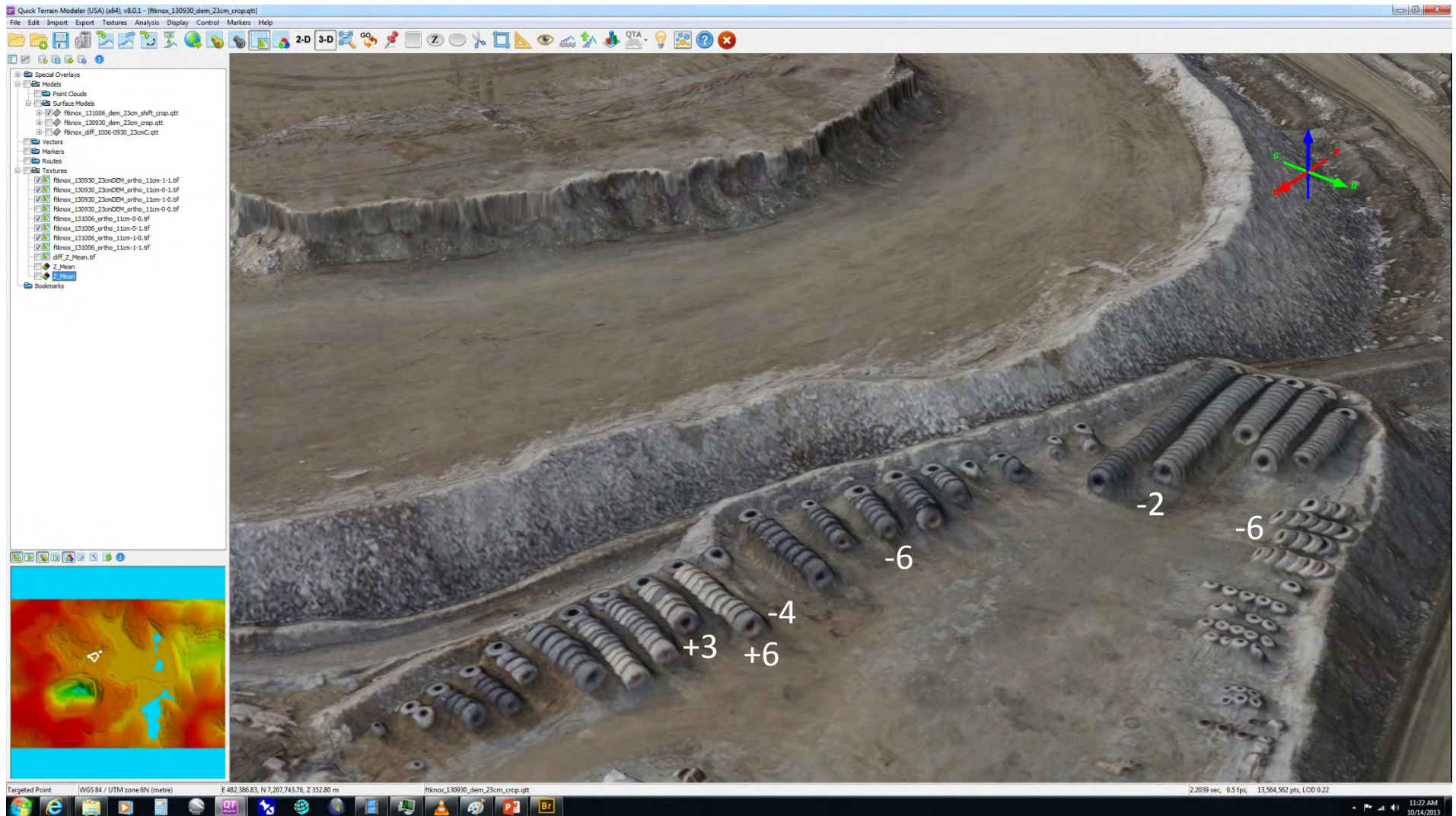
During the week, some of the tires were moved.

Spatial Resolution and Change Detection

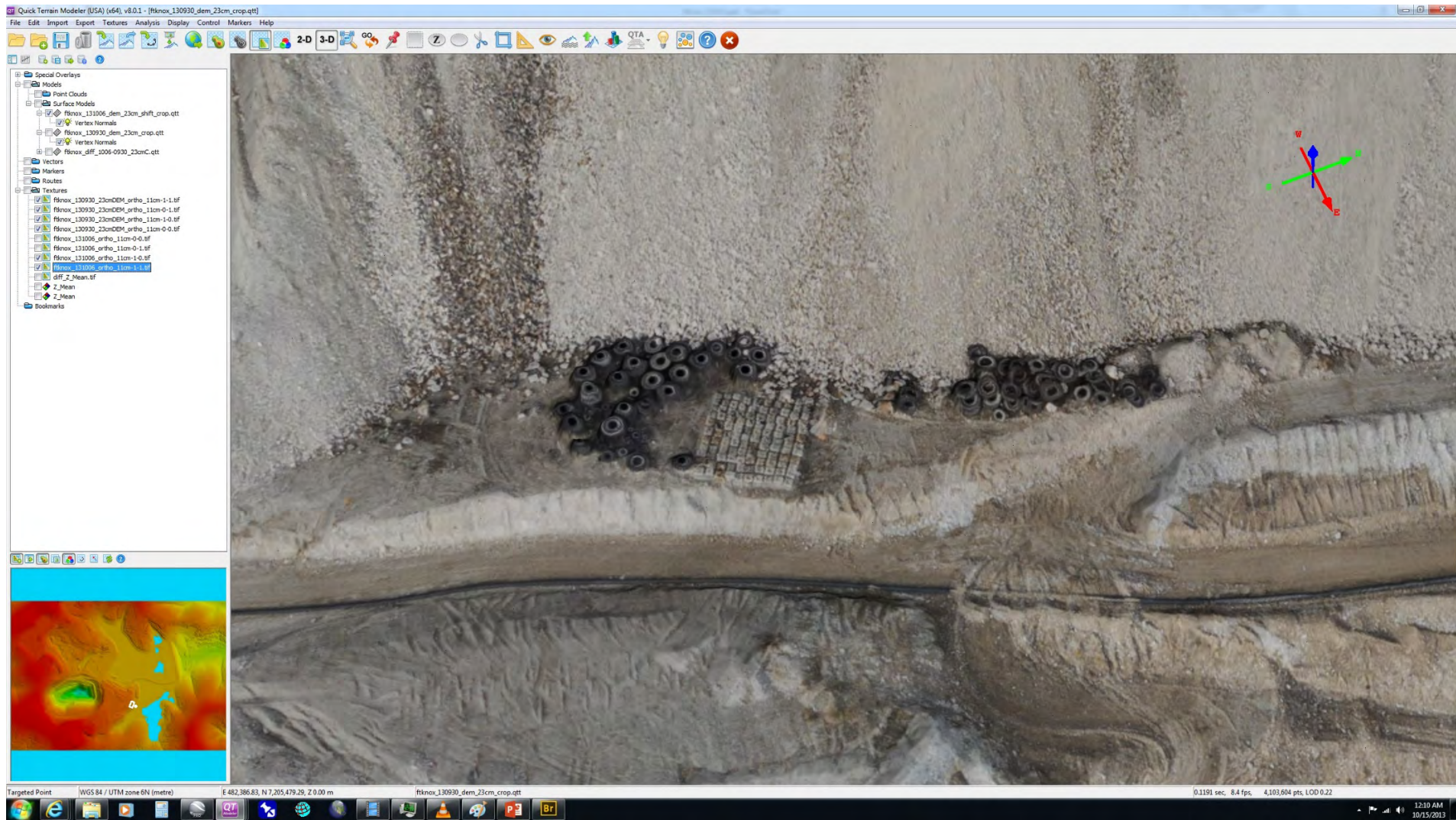


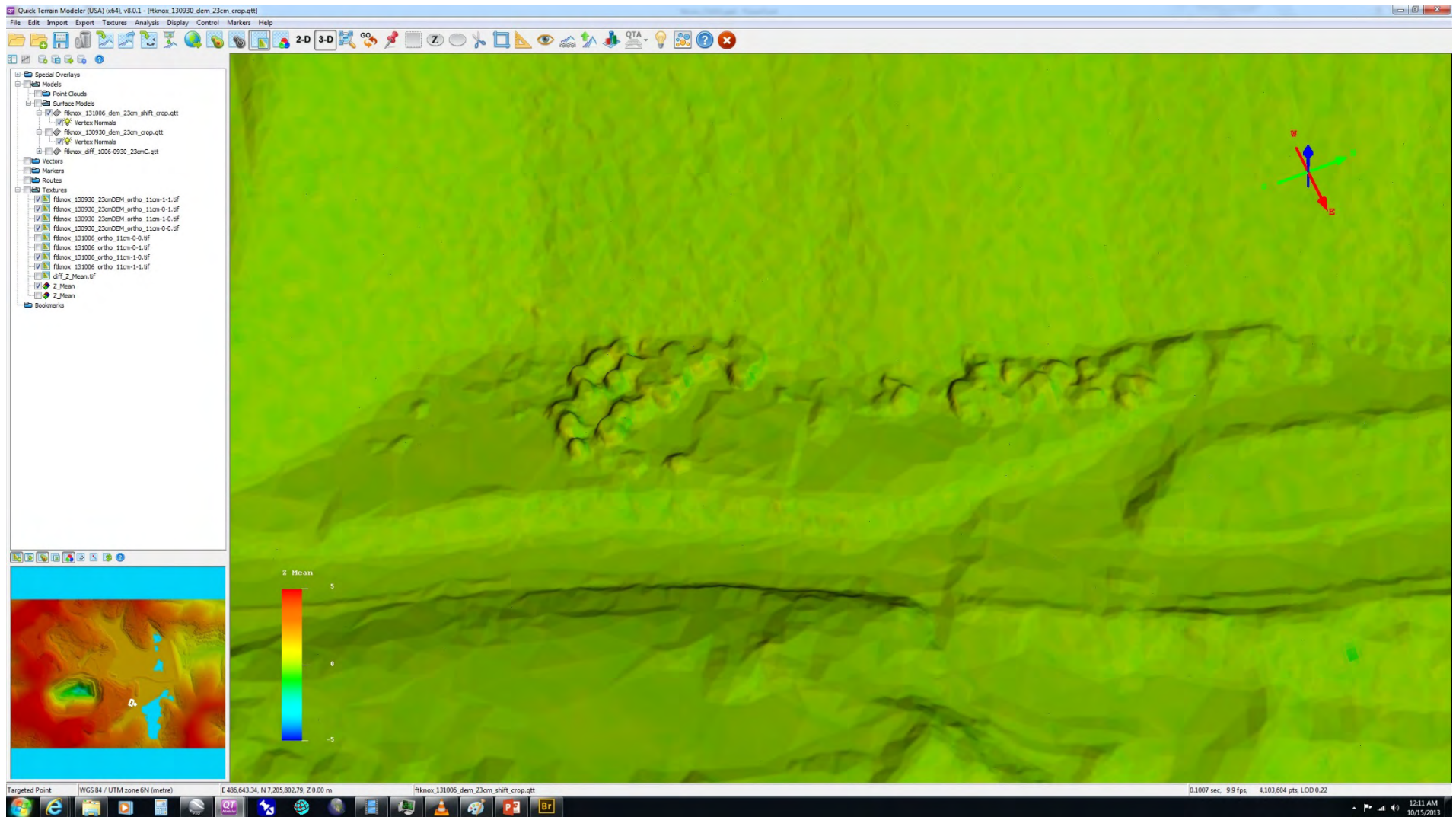
We can also detect this through volume change measurements.
The difference is about -5.5m^3 (red minus blue) or about 0.6m^3 per missing tire.

Spatial Resolution and Change Detection

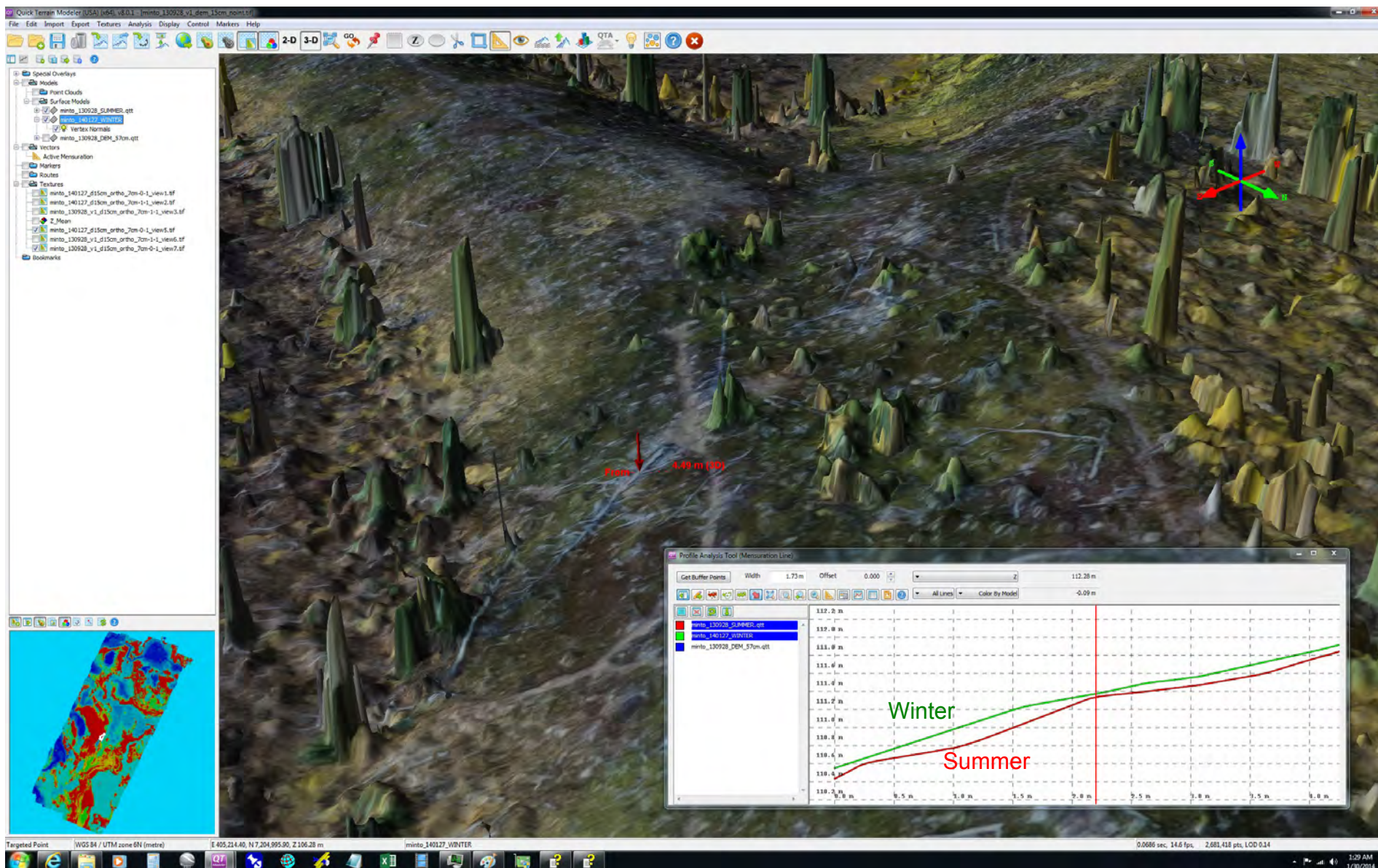


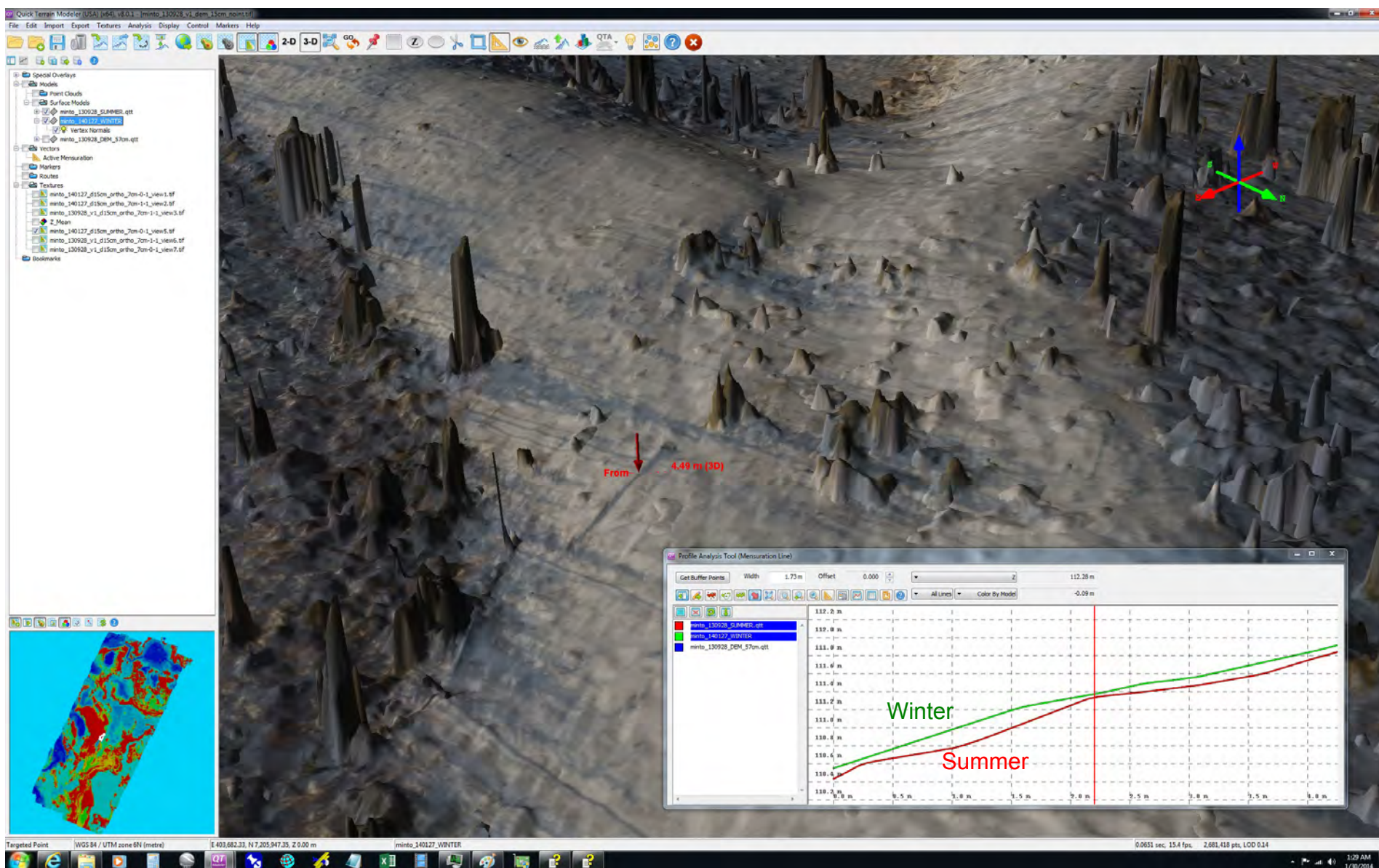
During the week, some of the tires were moved.
I counted them. **Nine** tires are missing!

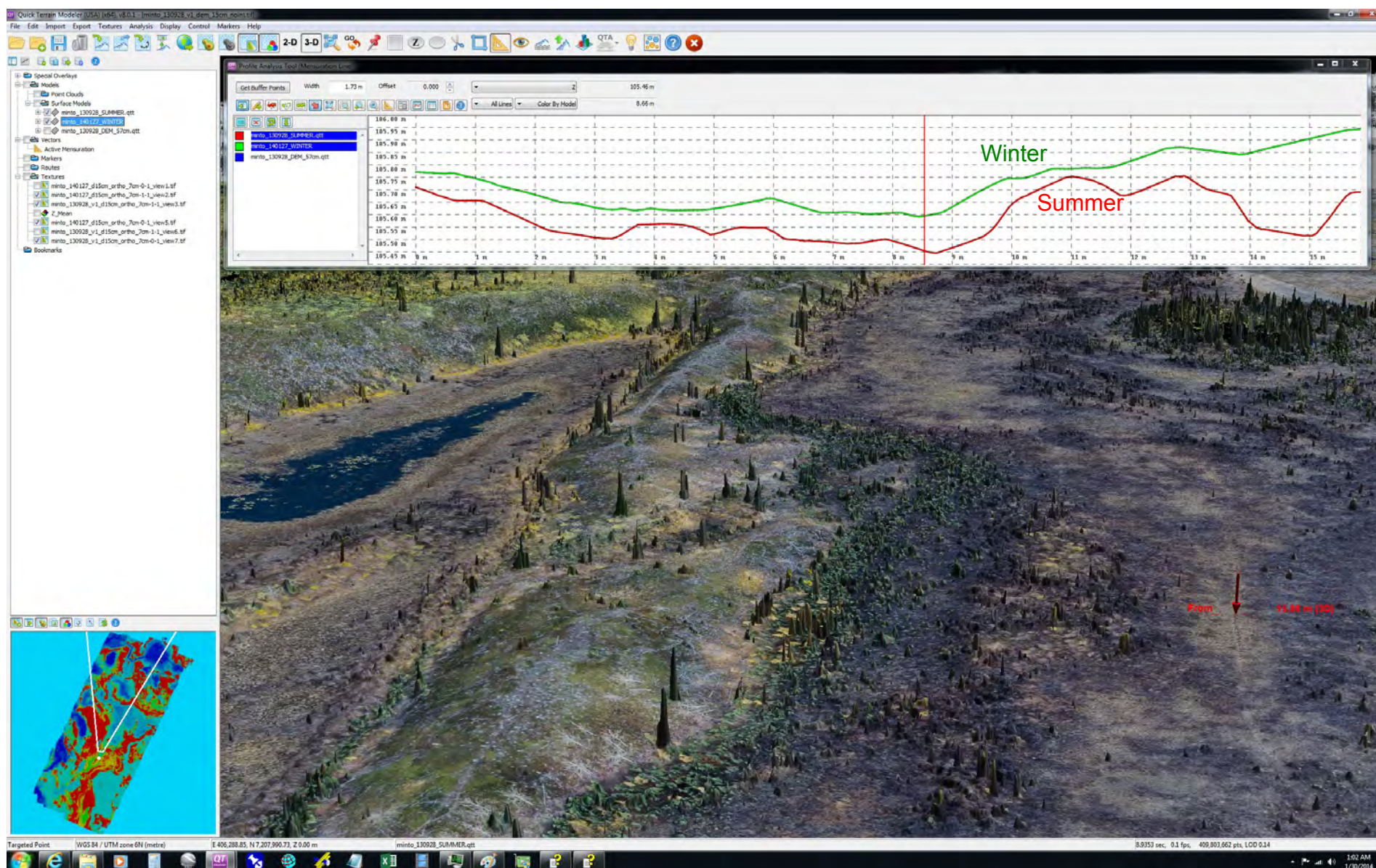


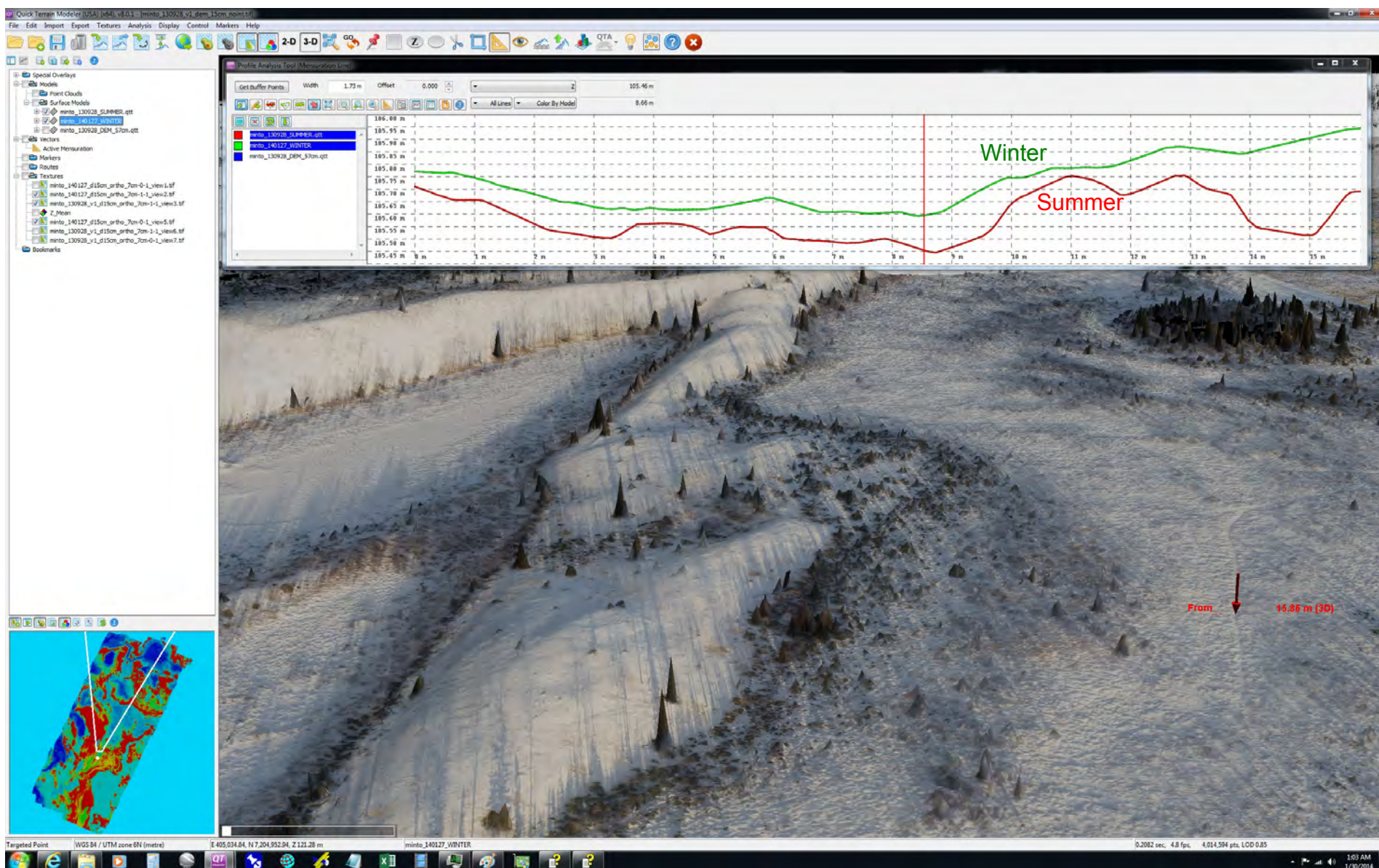


No change was detected here, so the missing tires must be somewhere else.

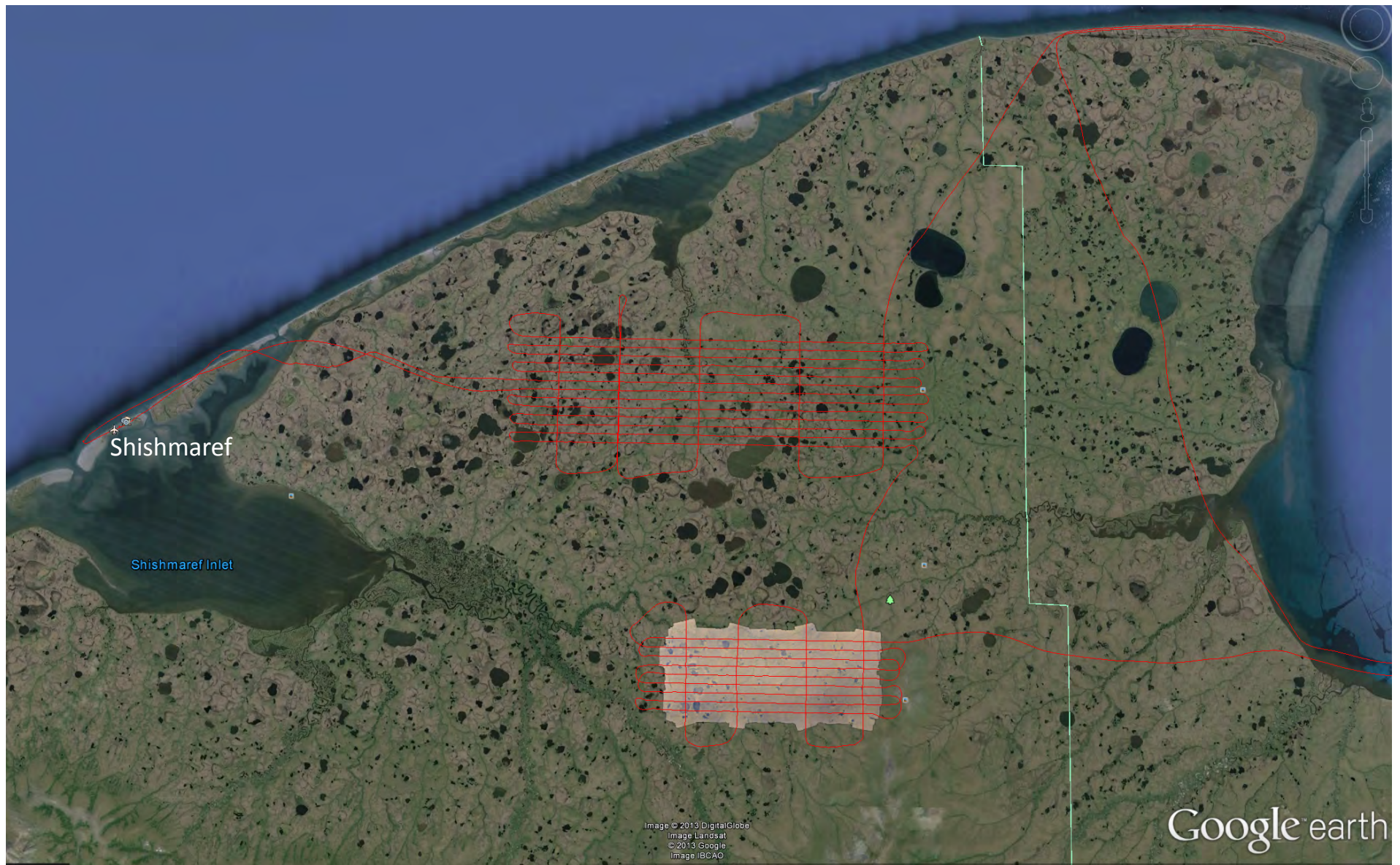




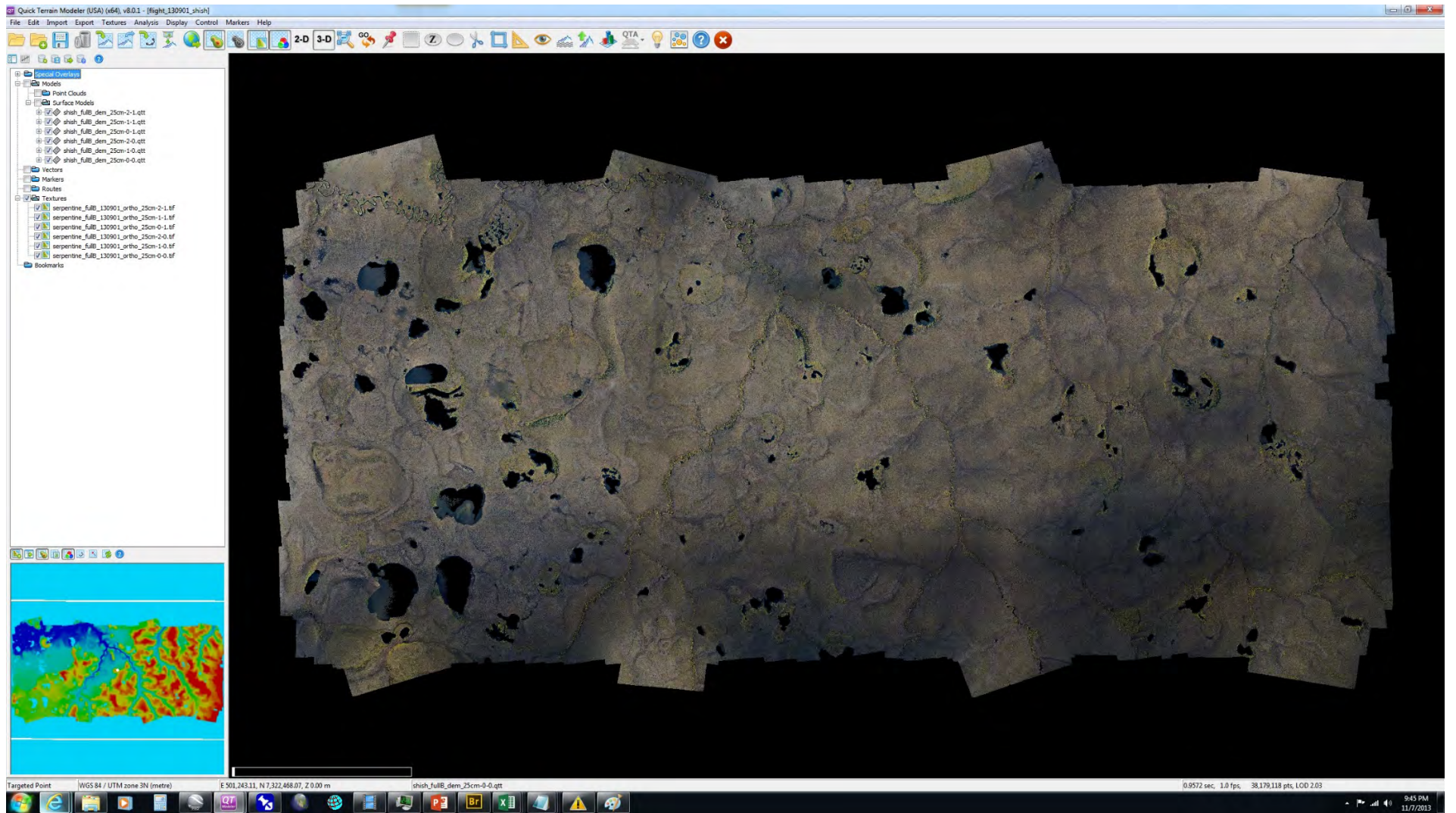


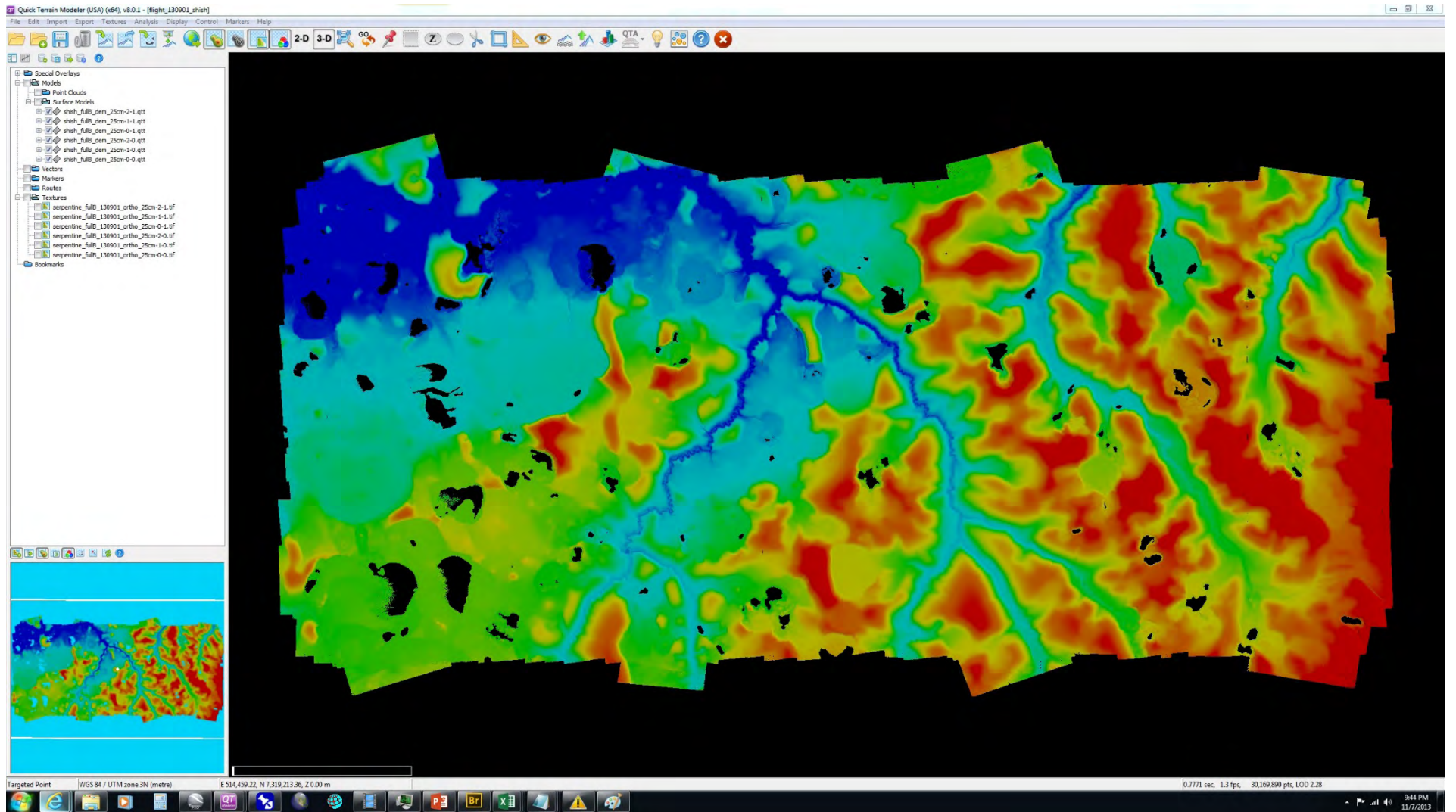


Shishmaref Area

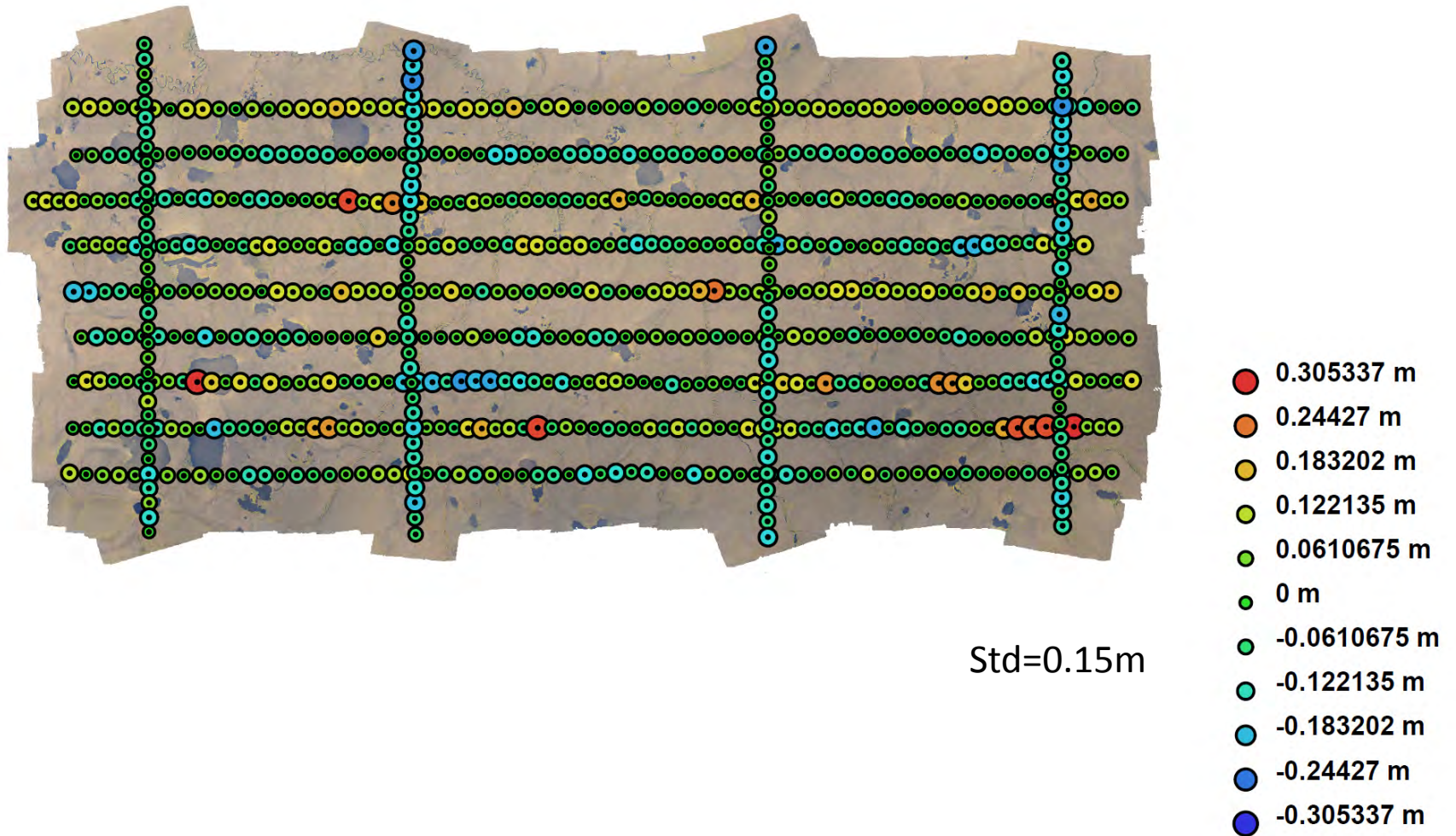


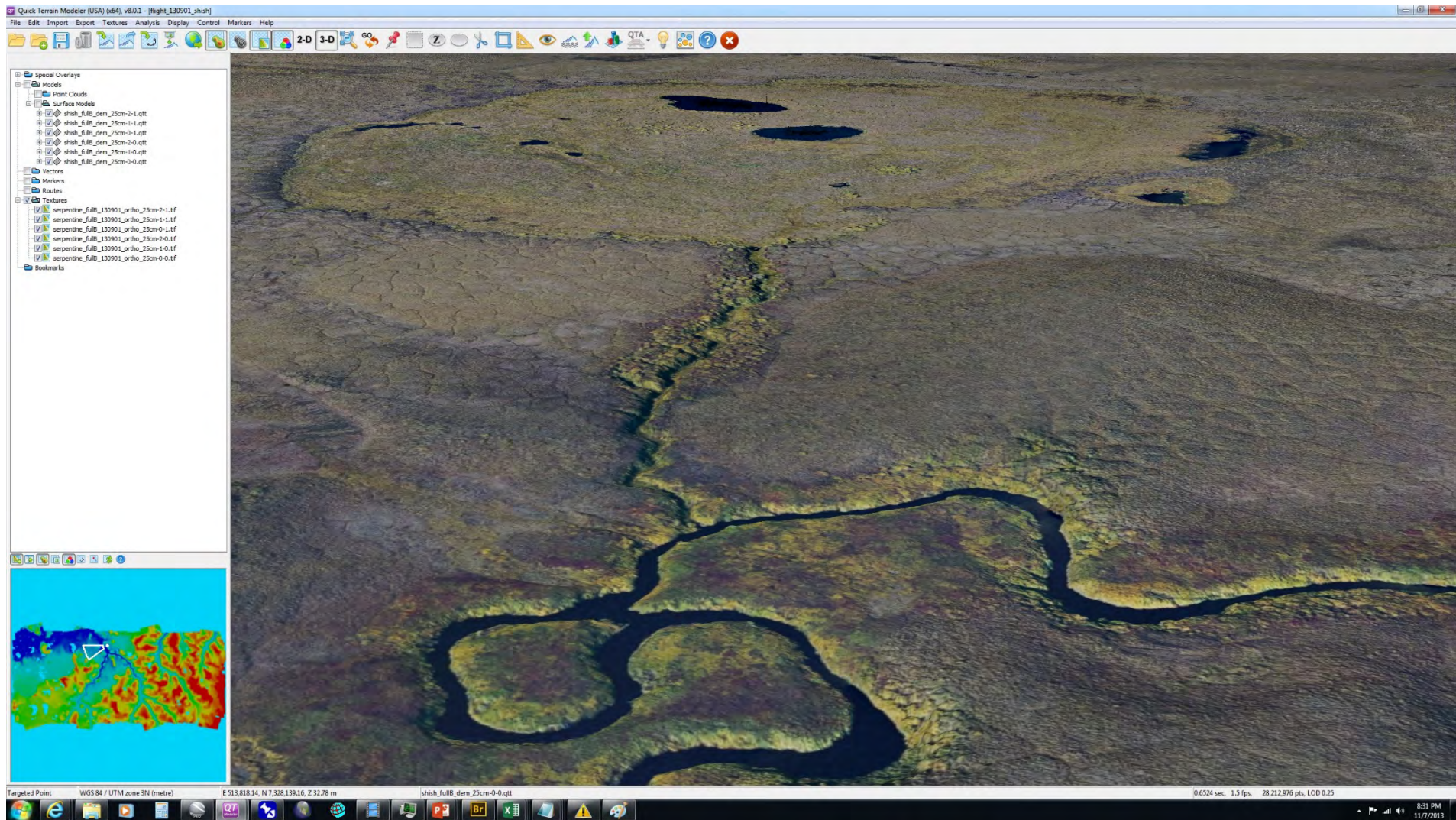
Nolan 2013: Example Photogrammetry Results

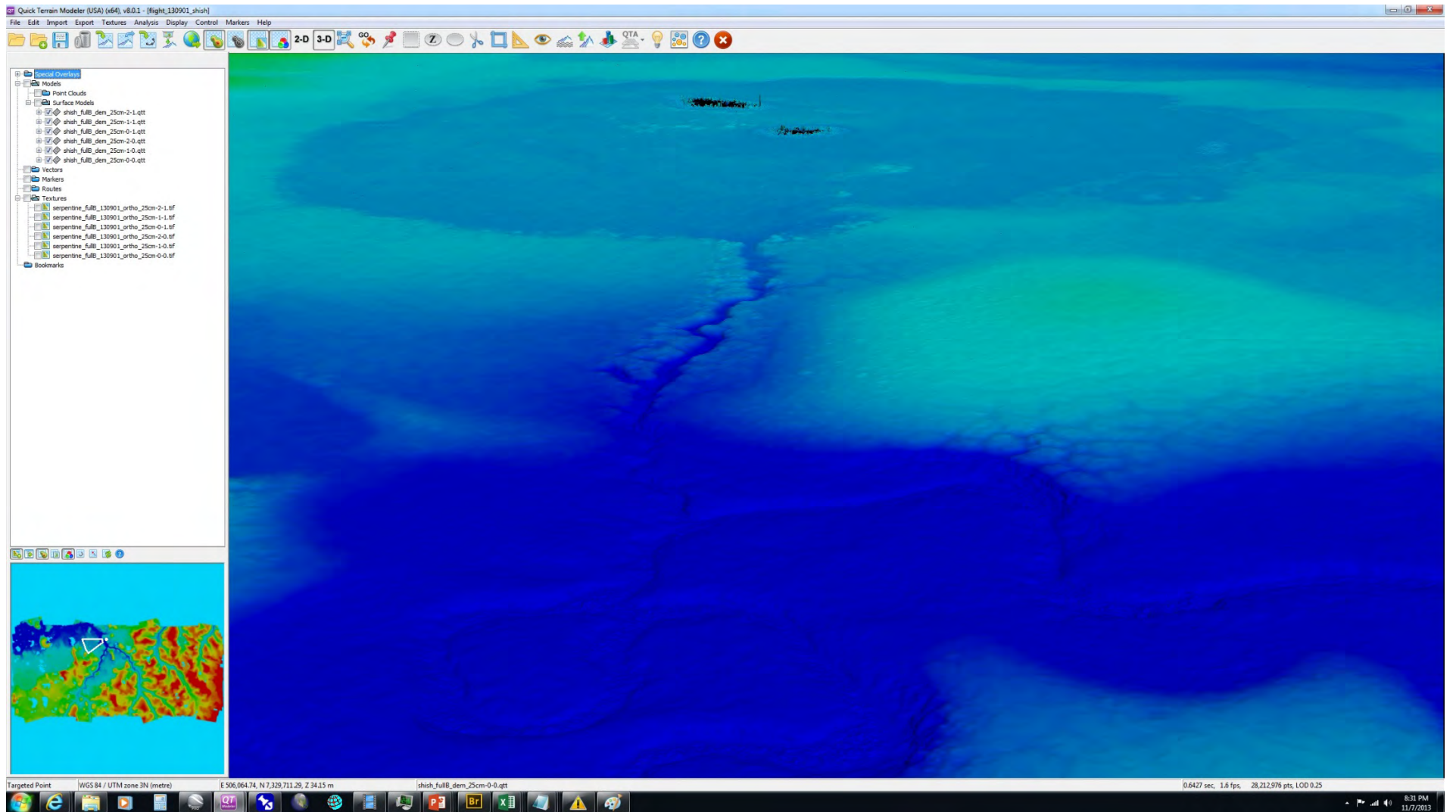


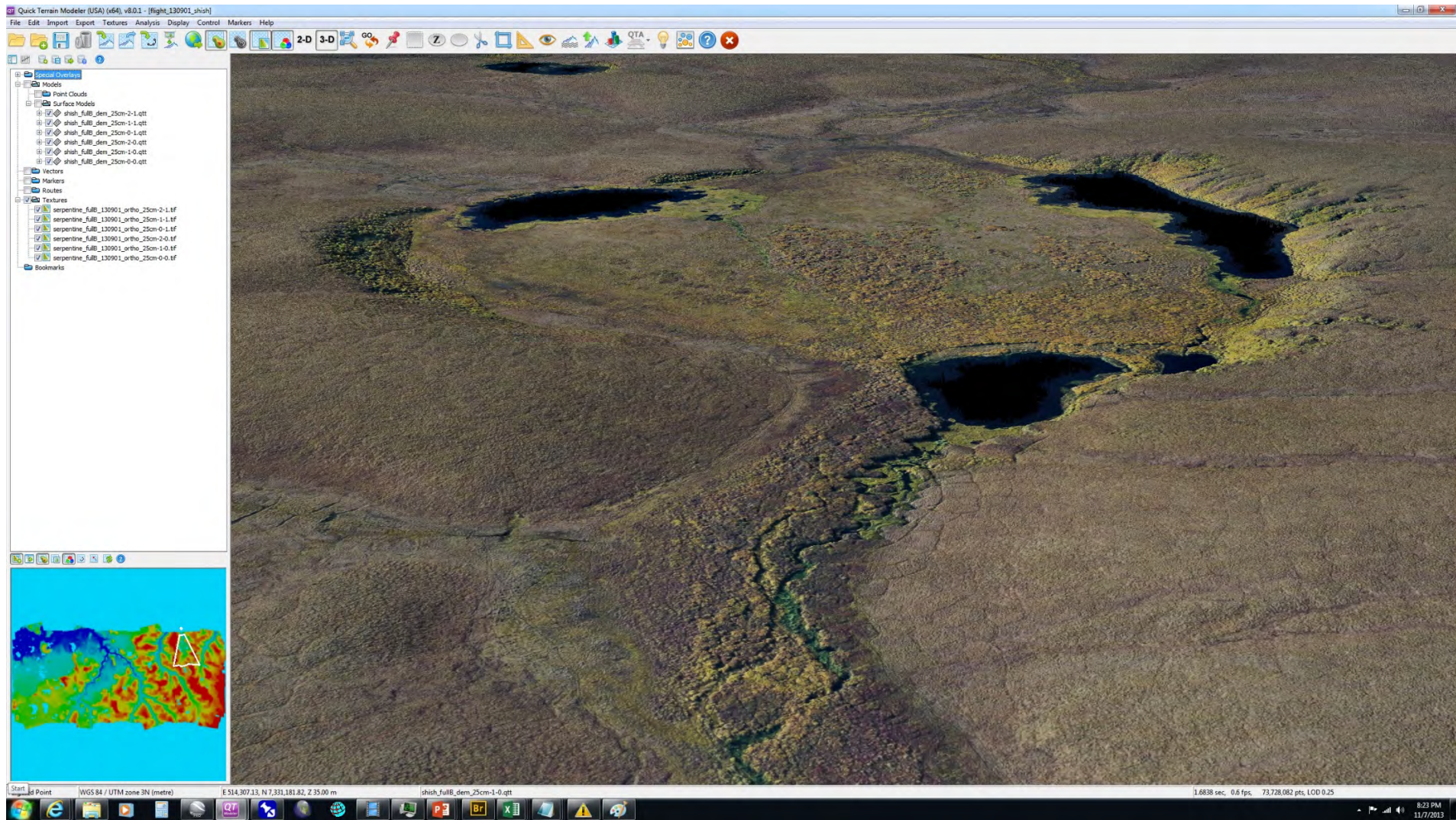


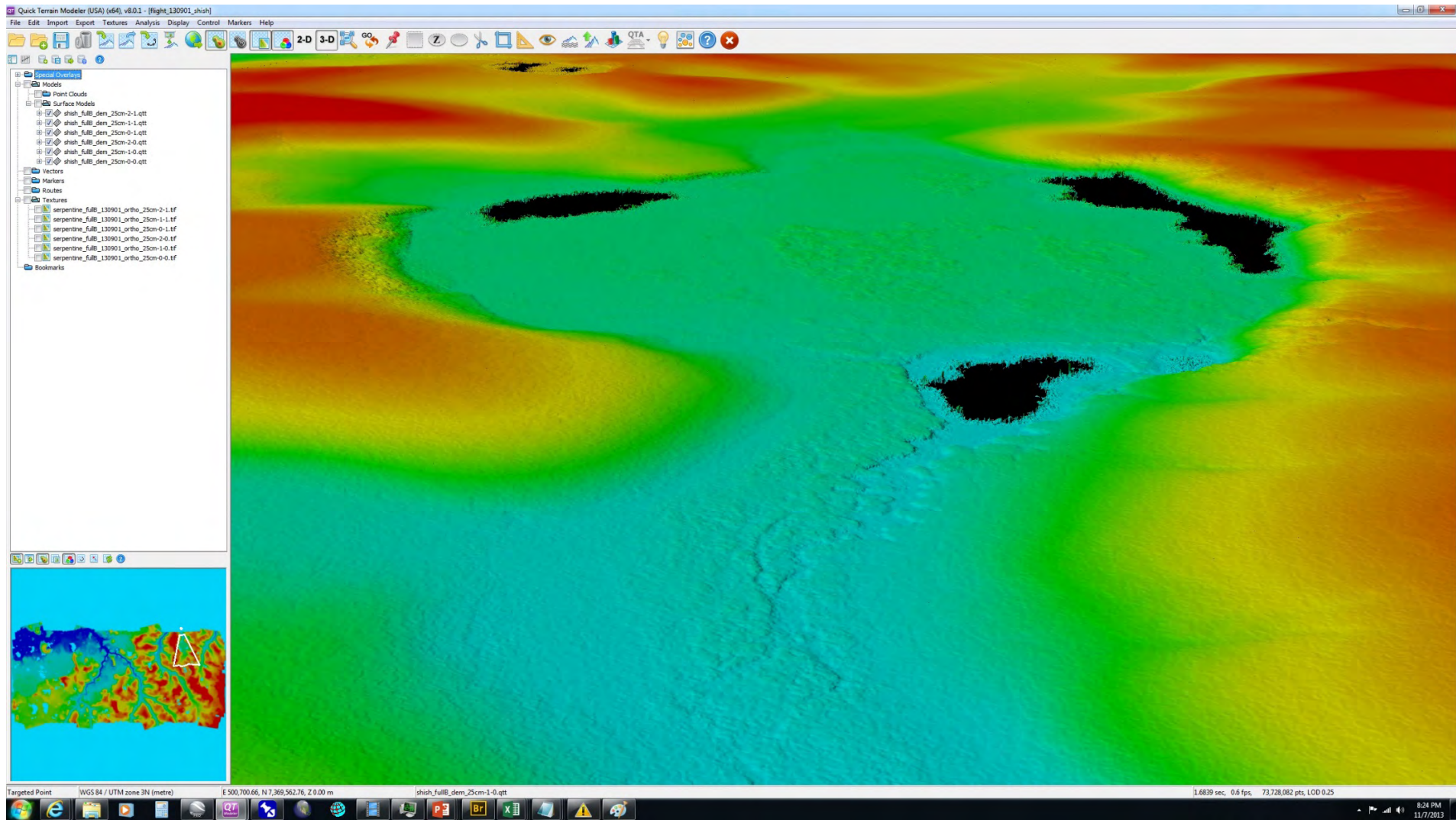
Assessment of absolute x,y,z accuracy

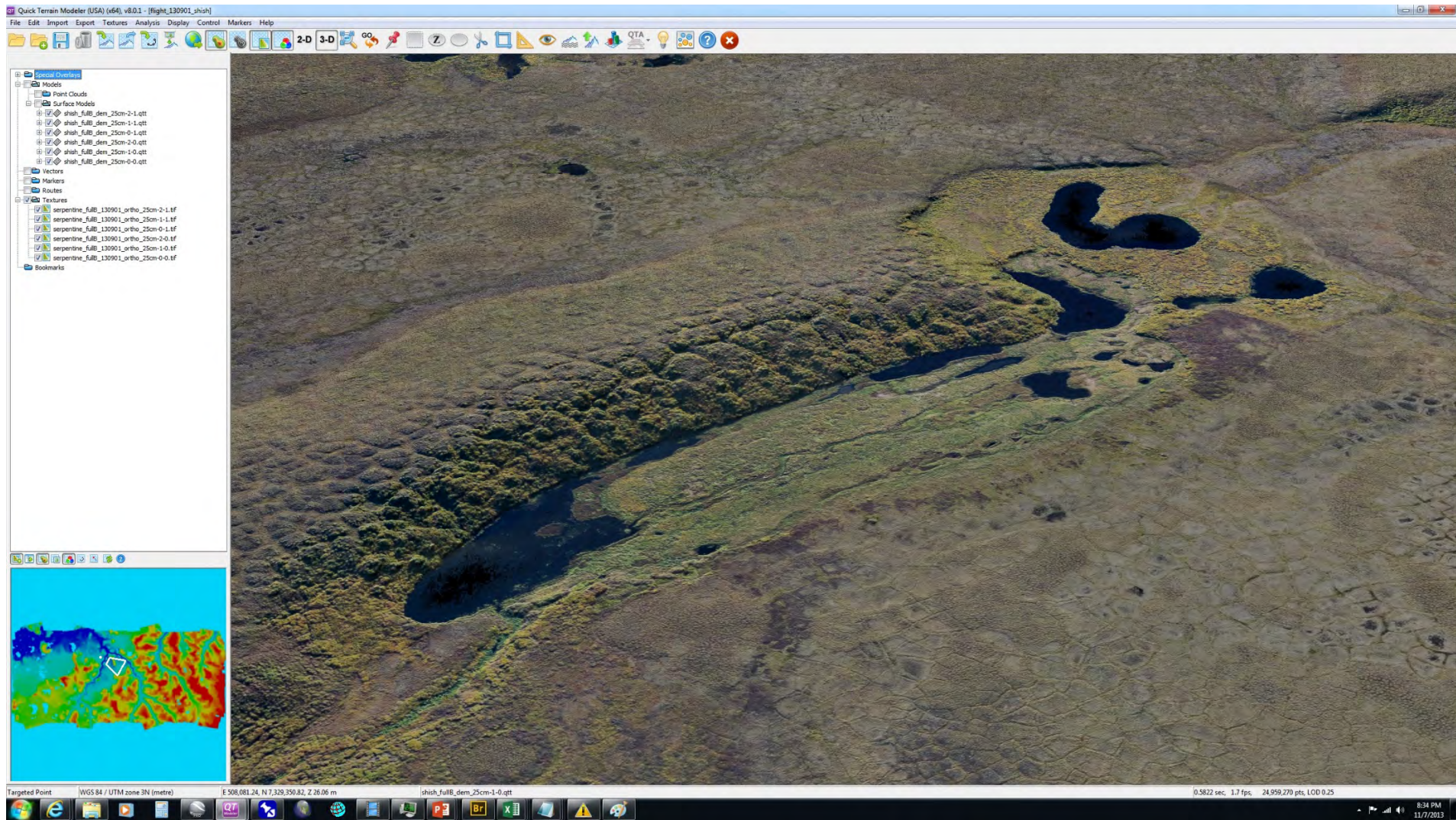


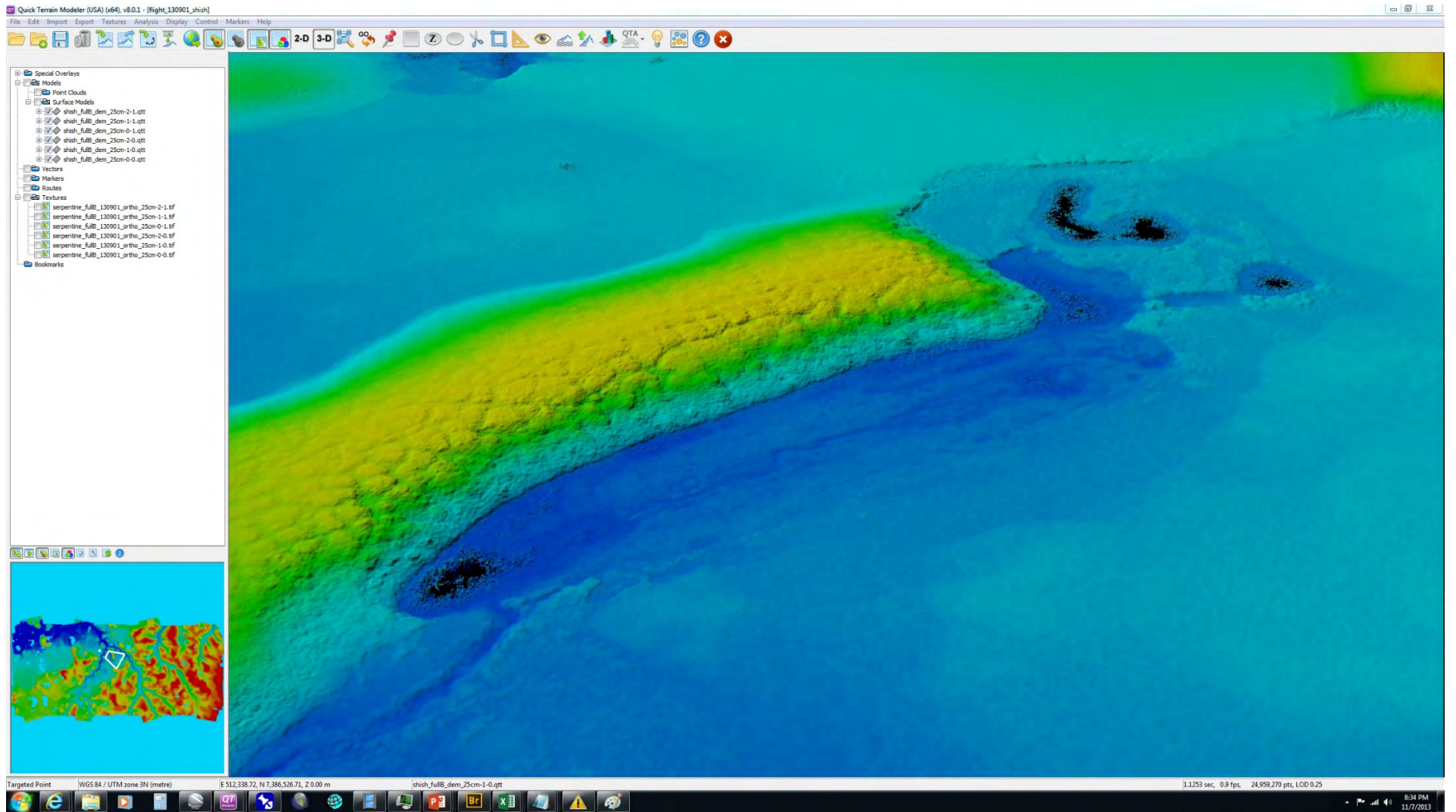


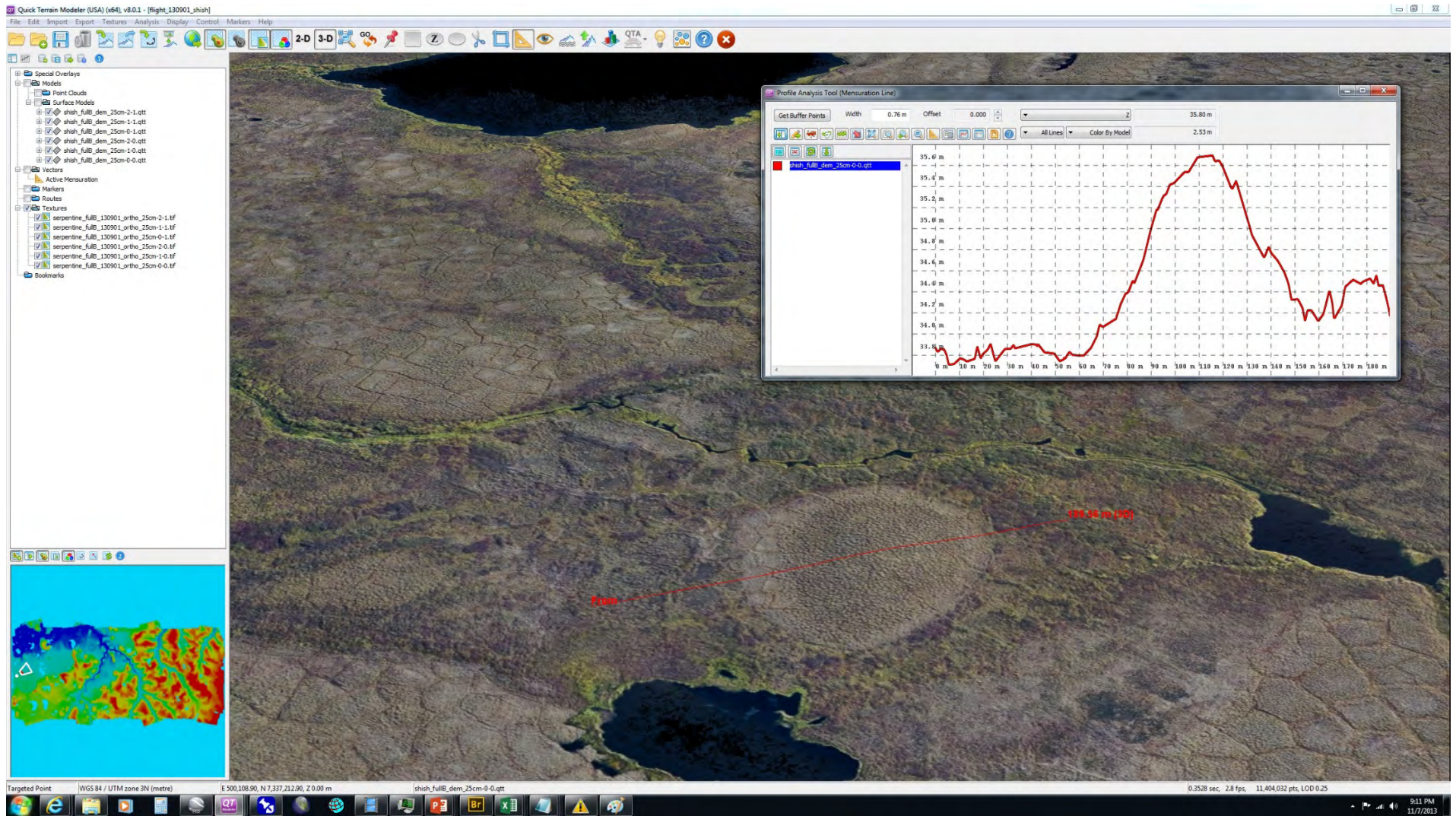


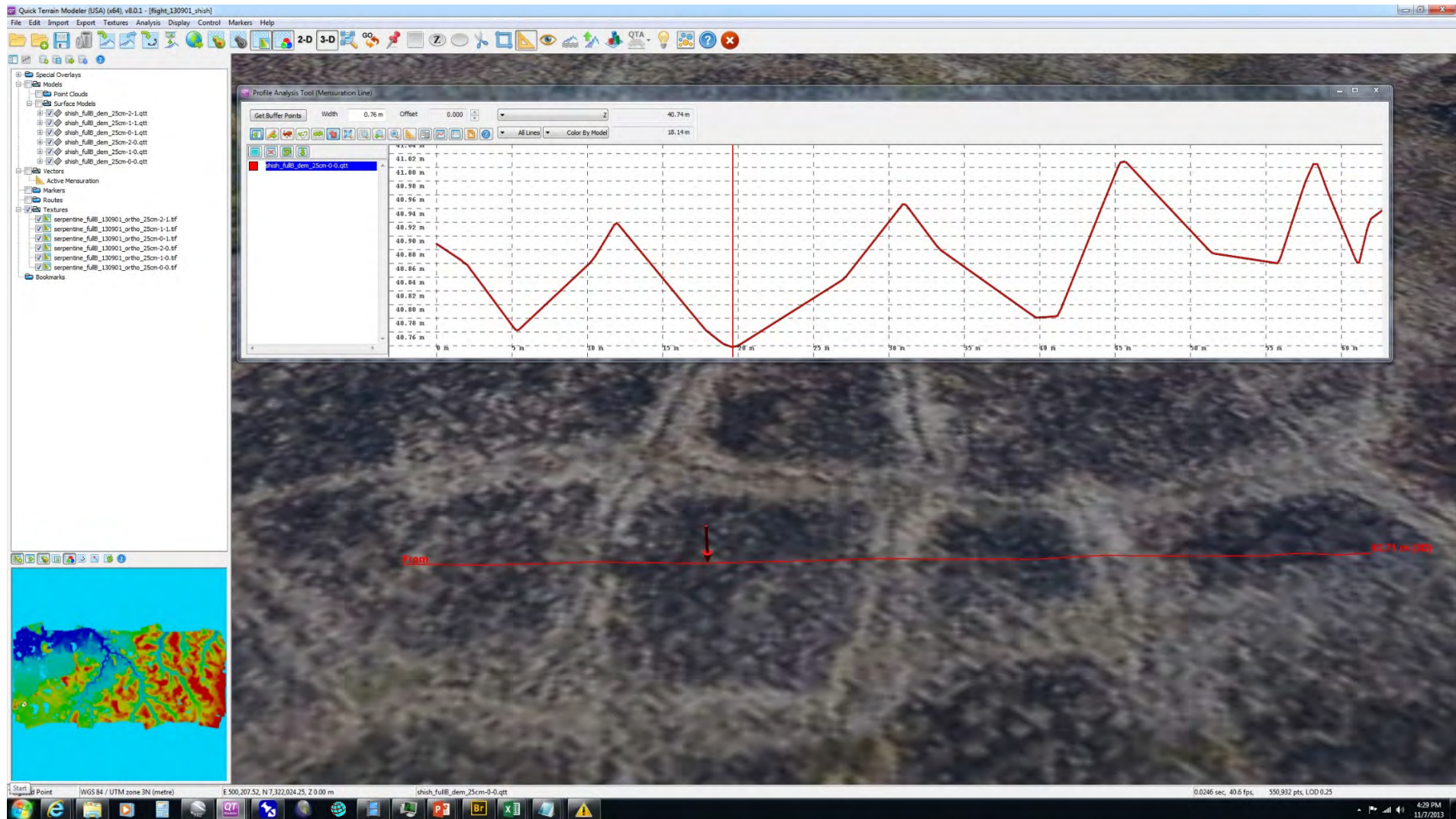


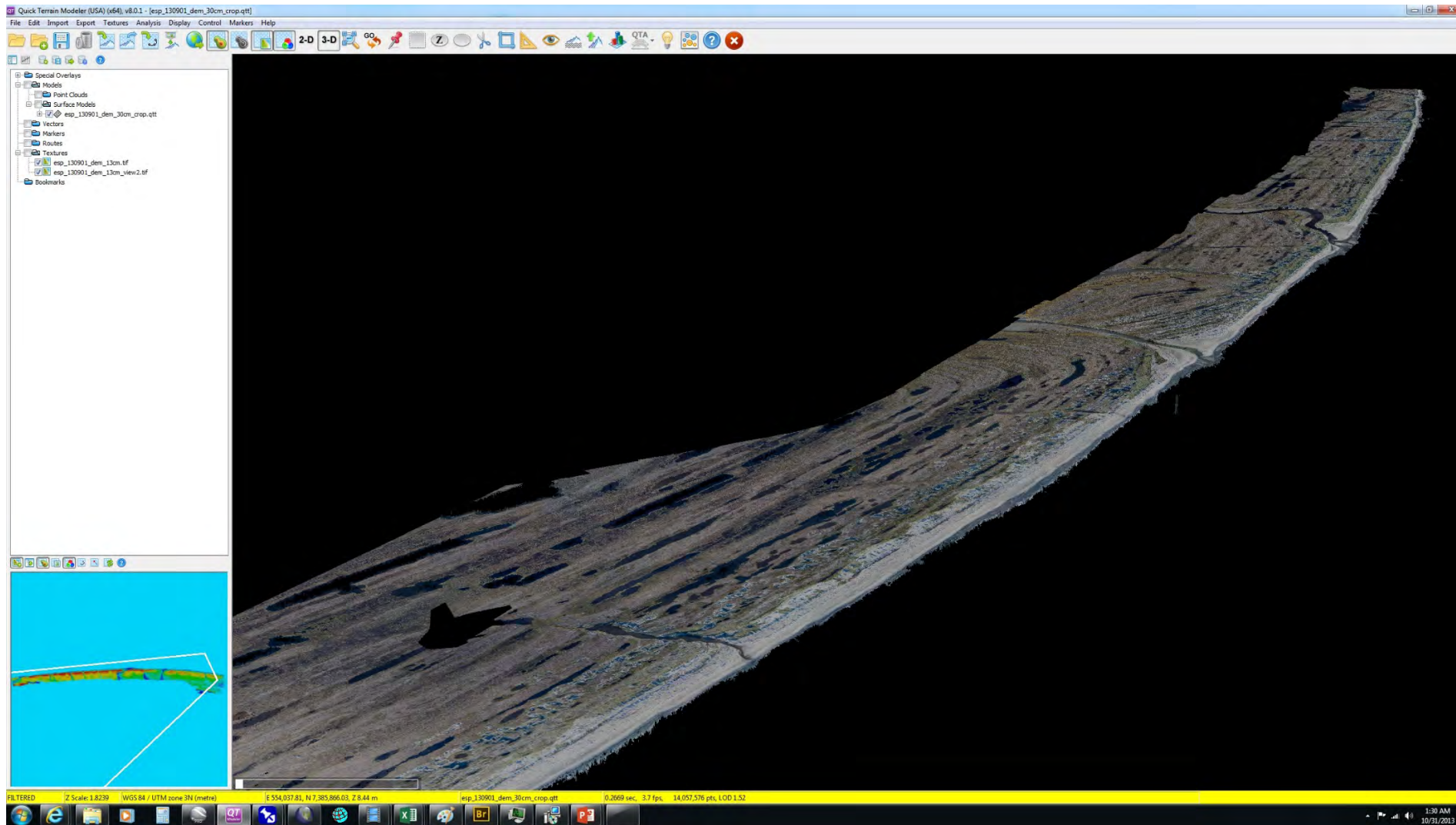


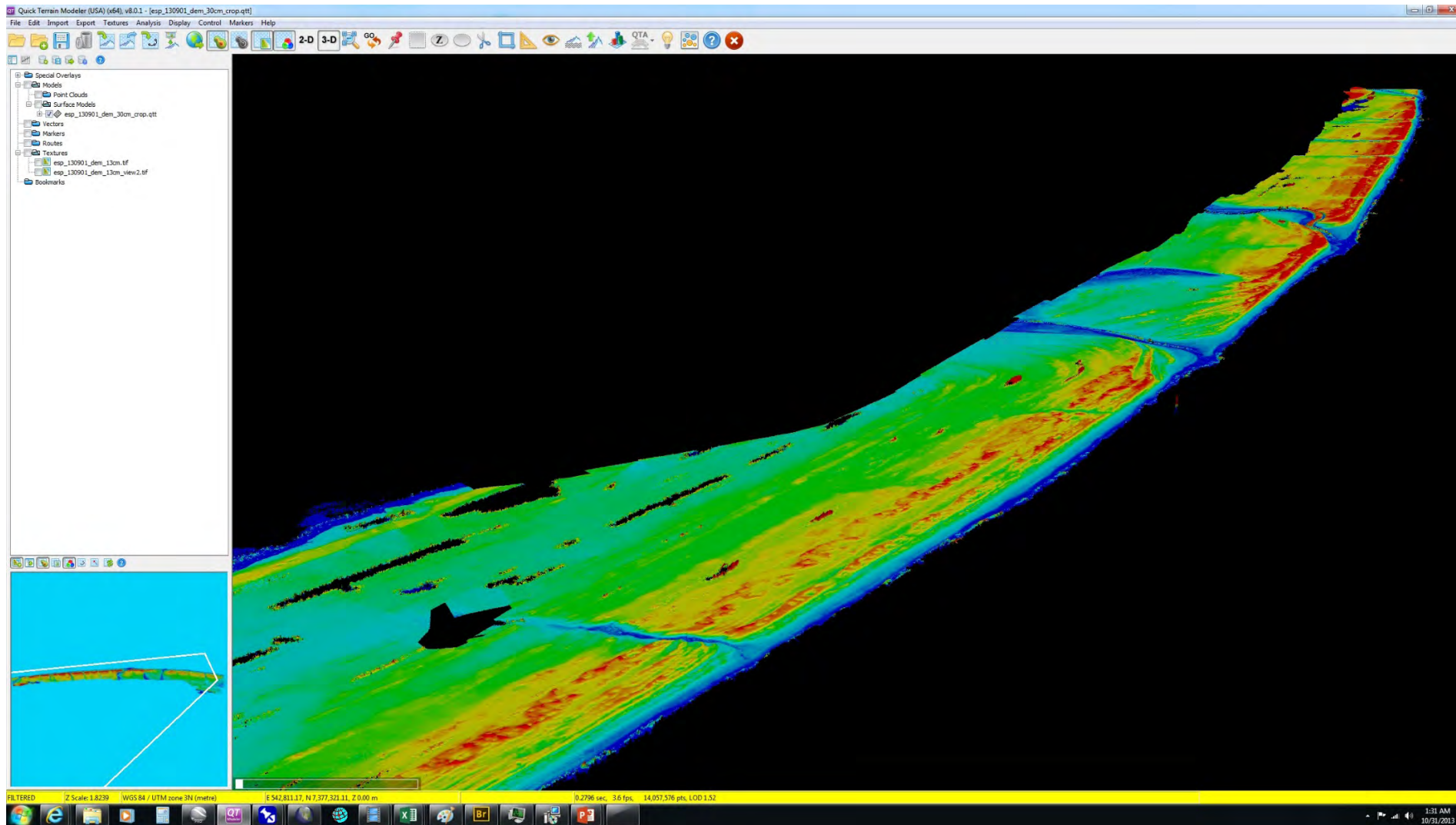


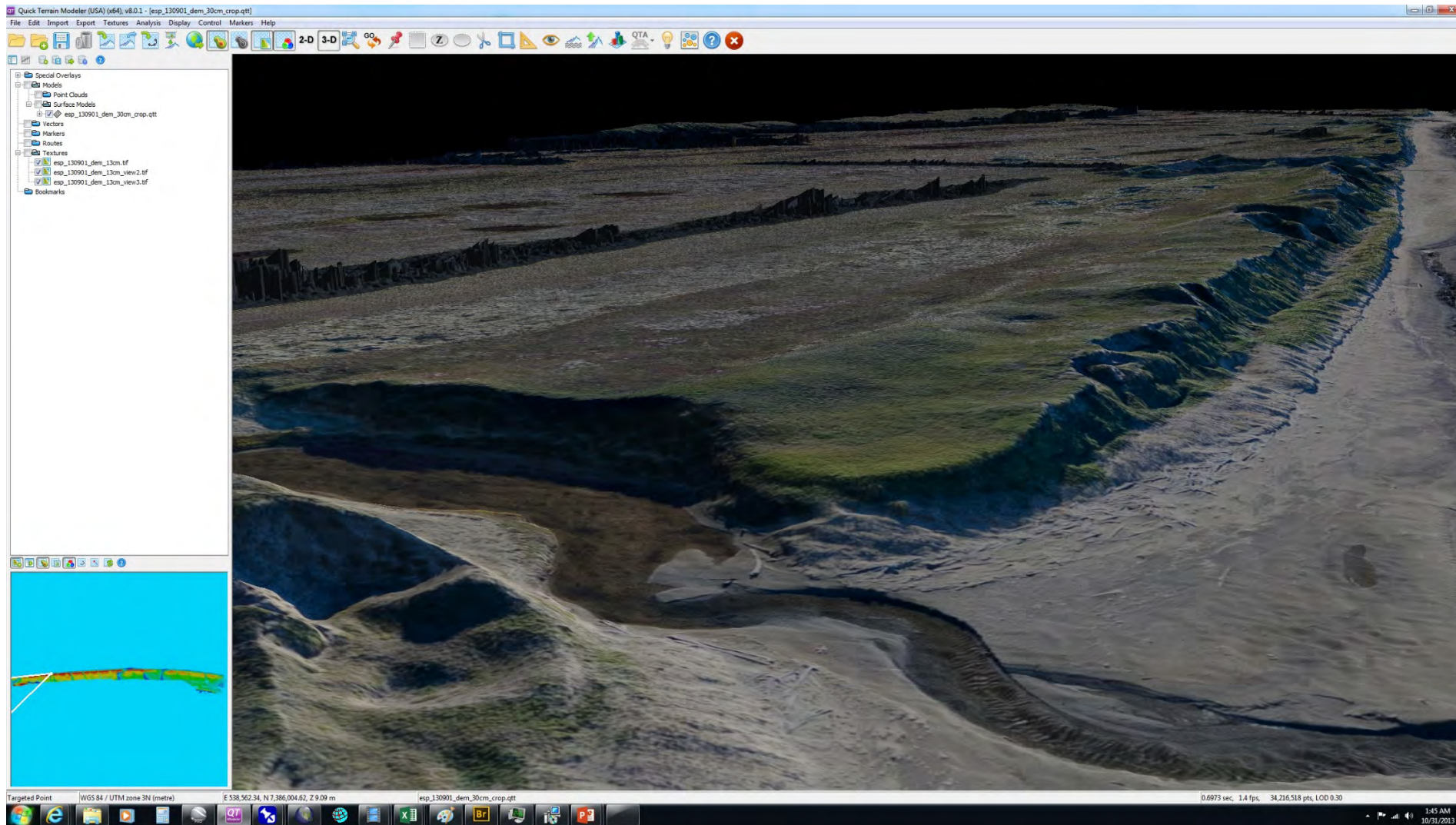


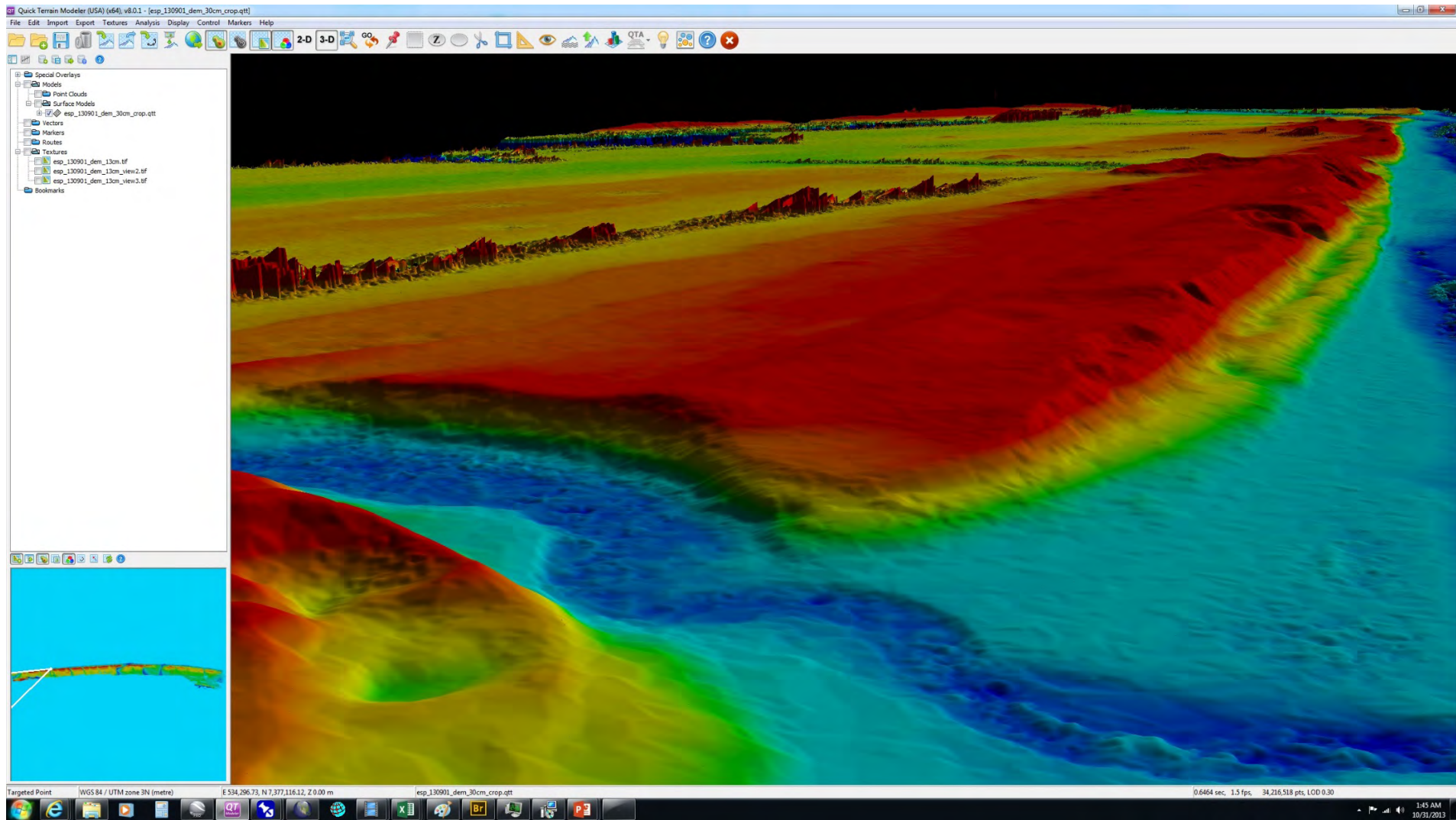




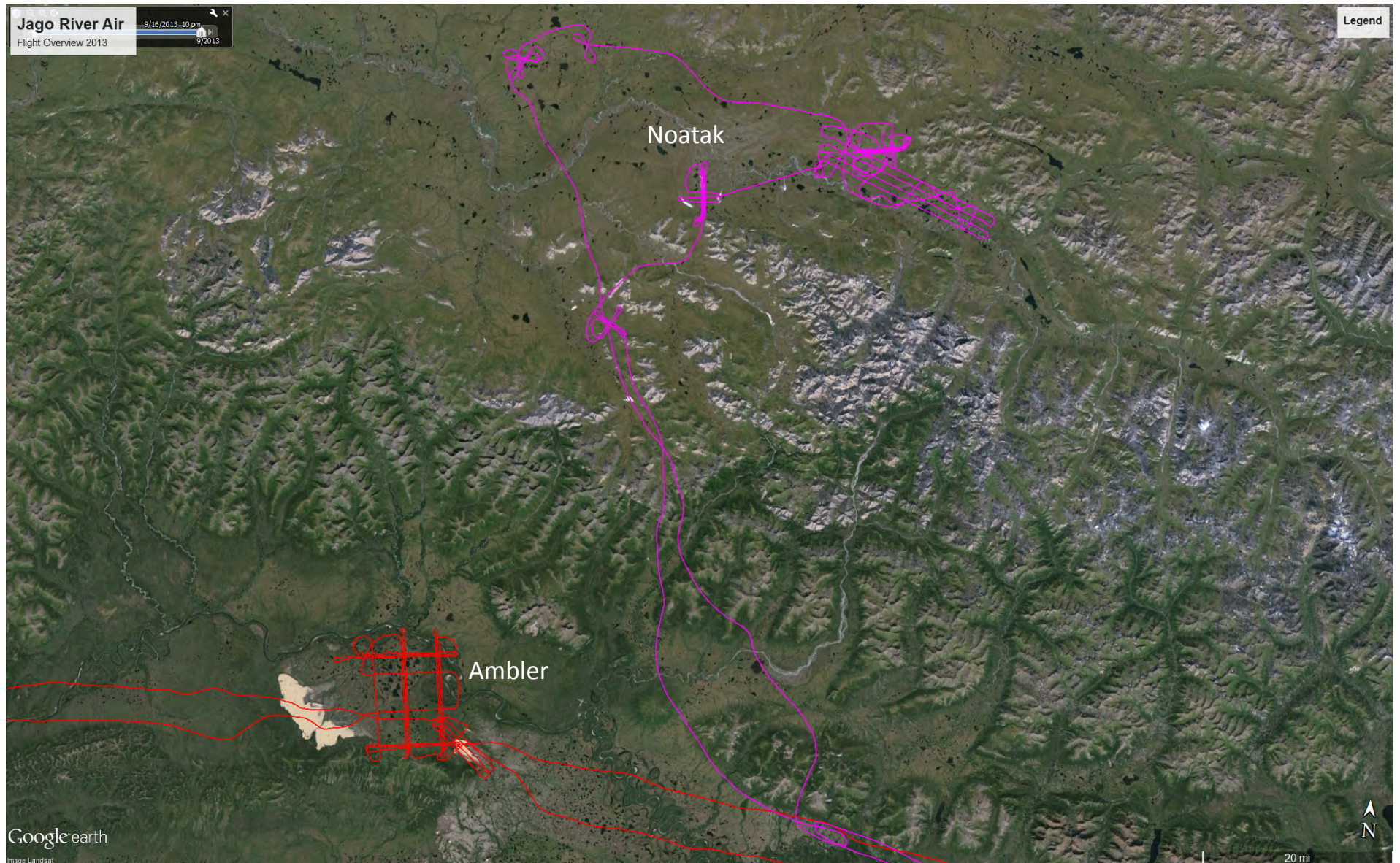






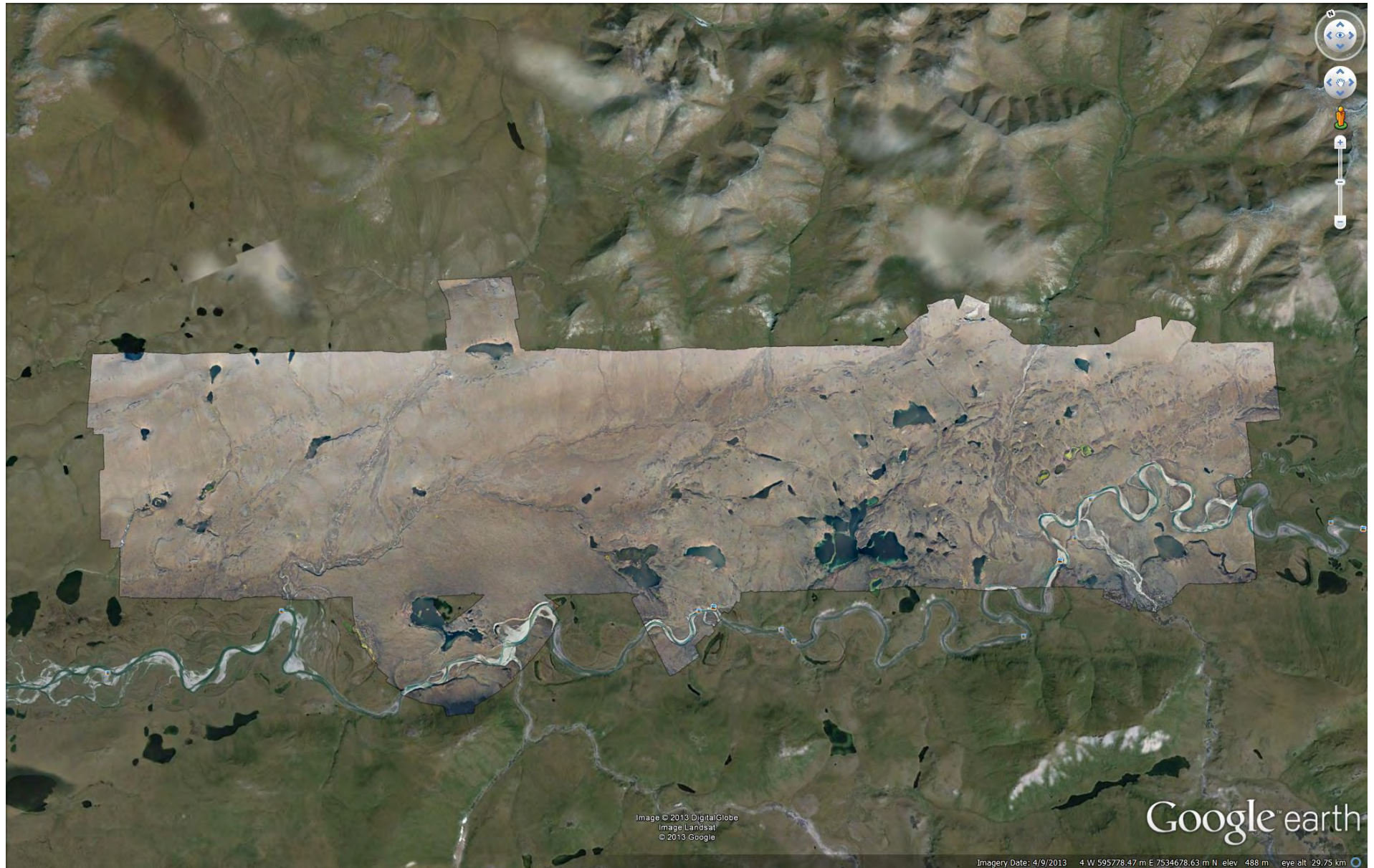


Noatak and Ambler Blocks

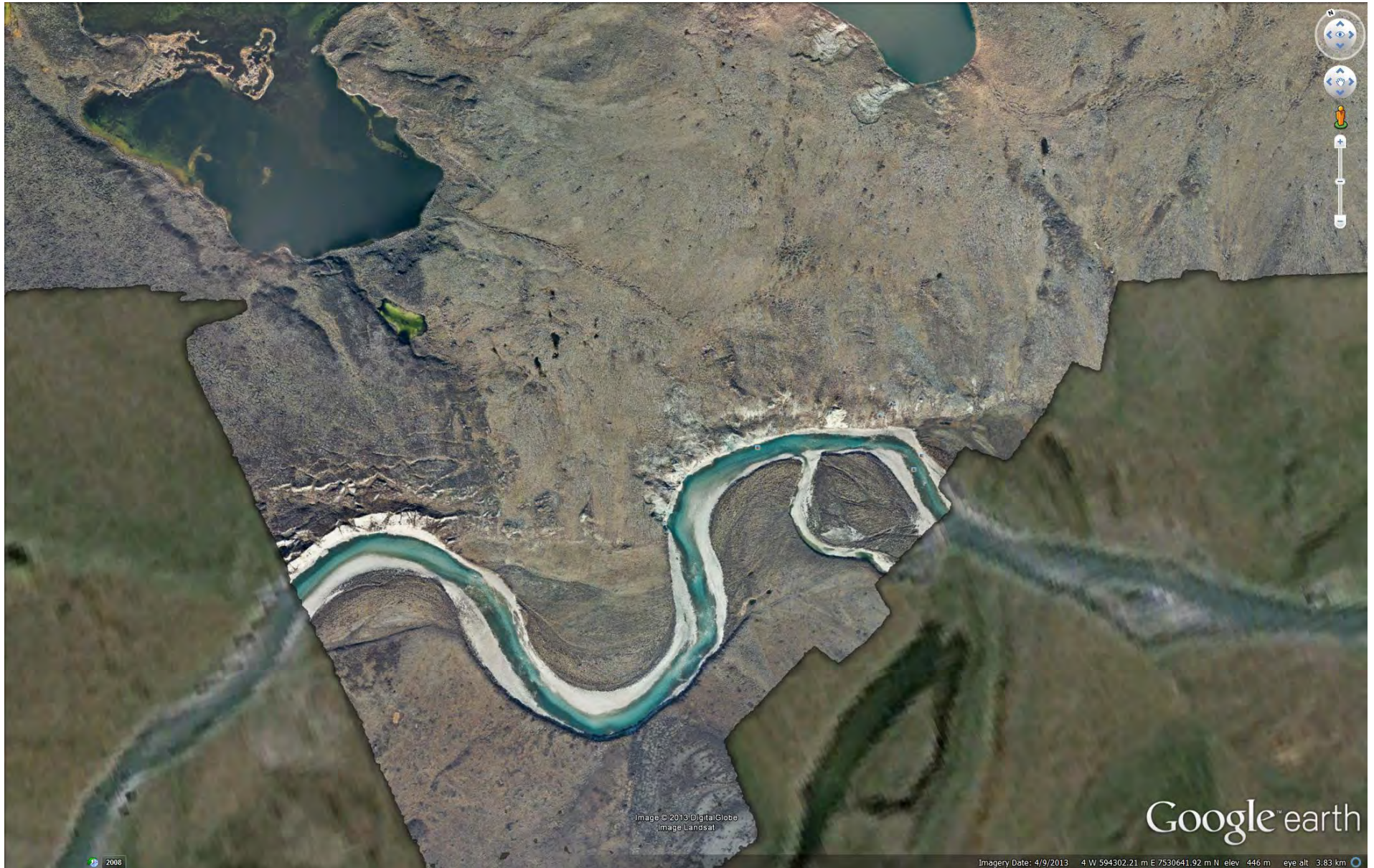


Nolan 2013: Example Photogrammetry Results

Assessment of absolute x,y,z accuracy

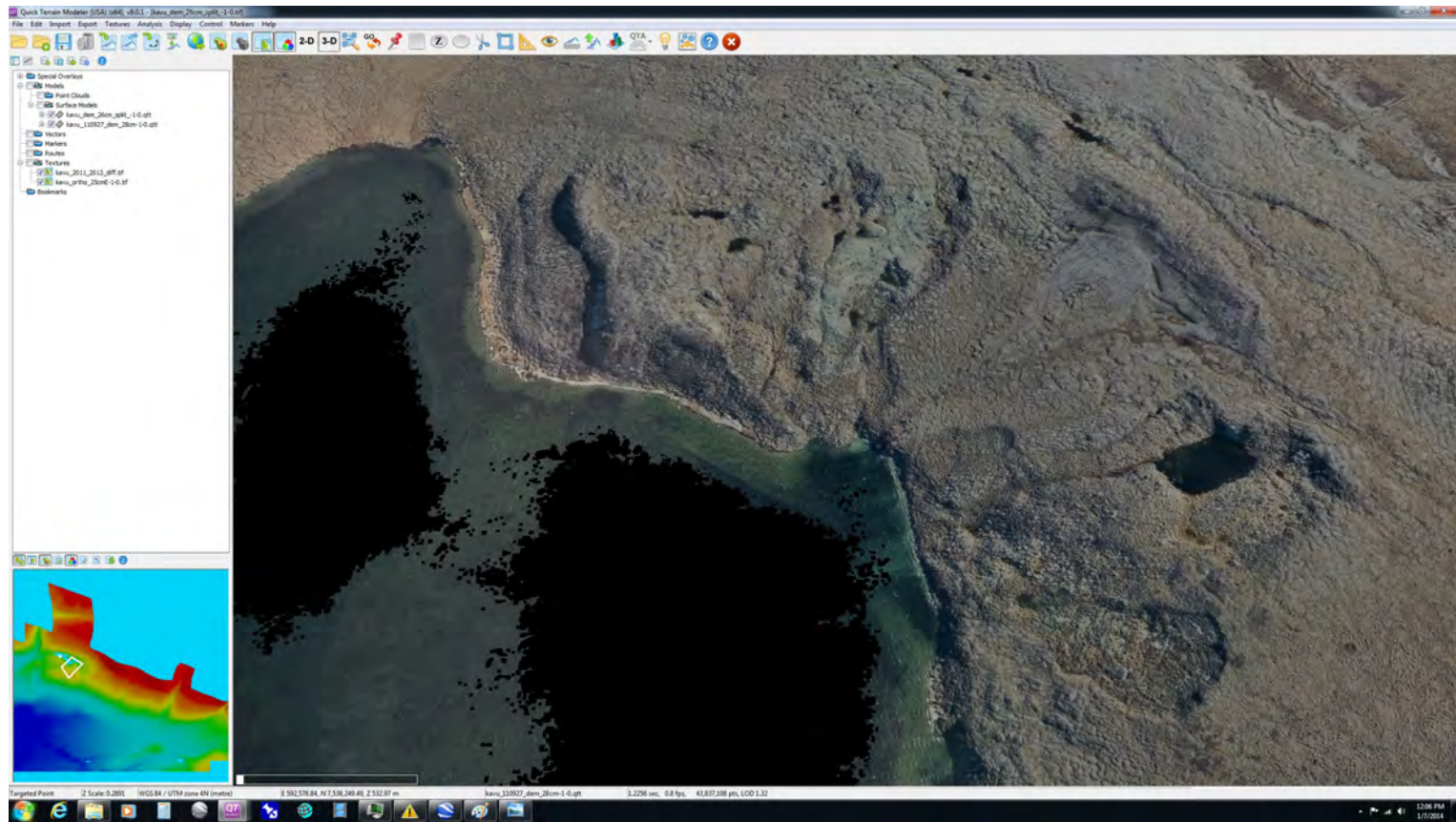


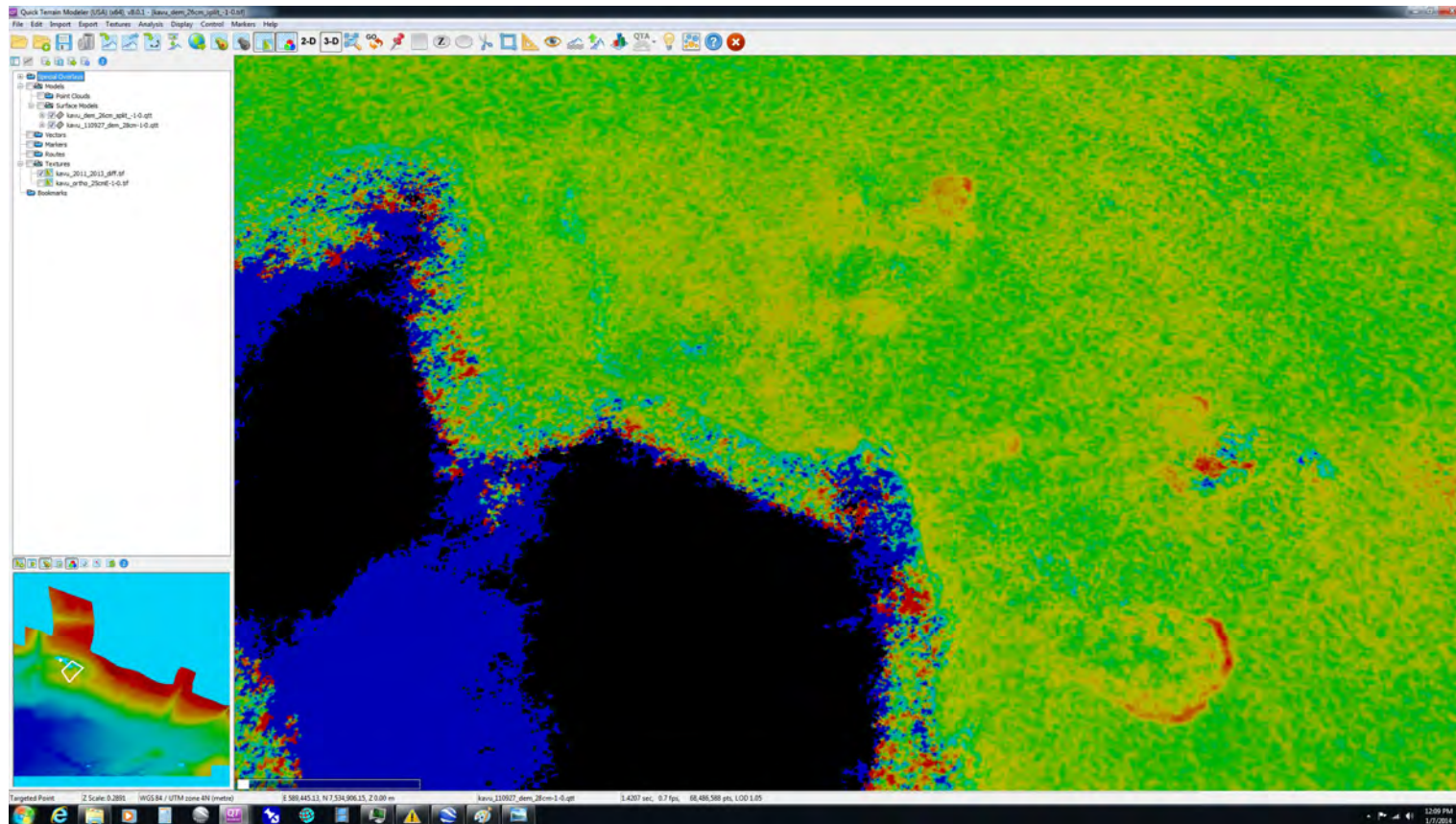
Assessment of absolute x,y,z accuracy



Assessment of absolute x,y,z accuracy

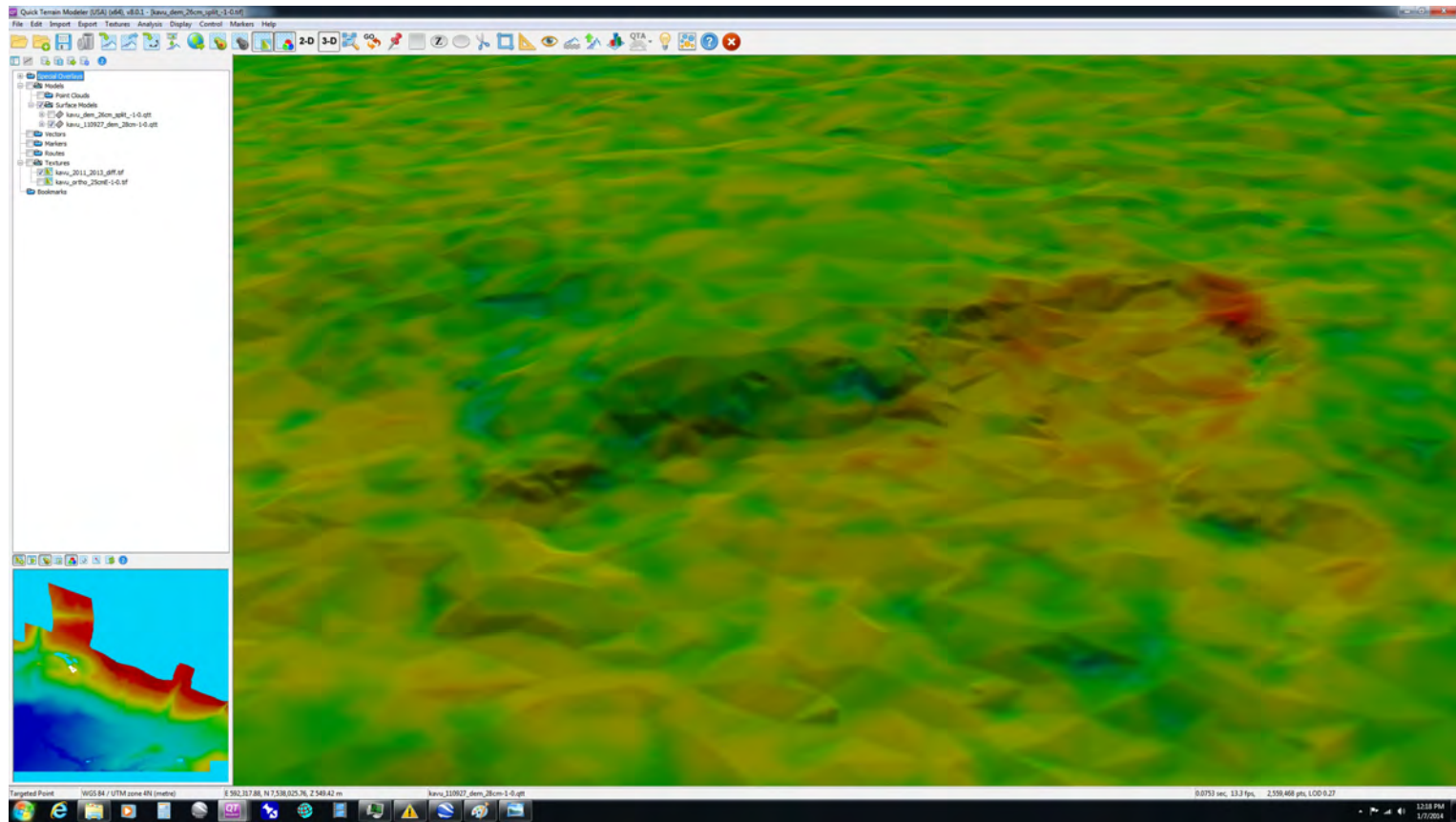


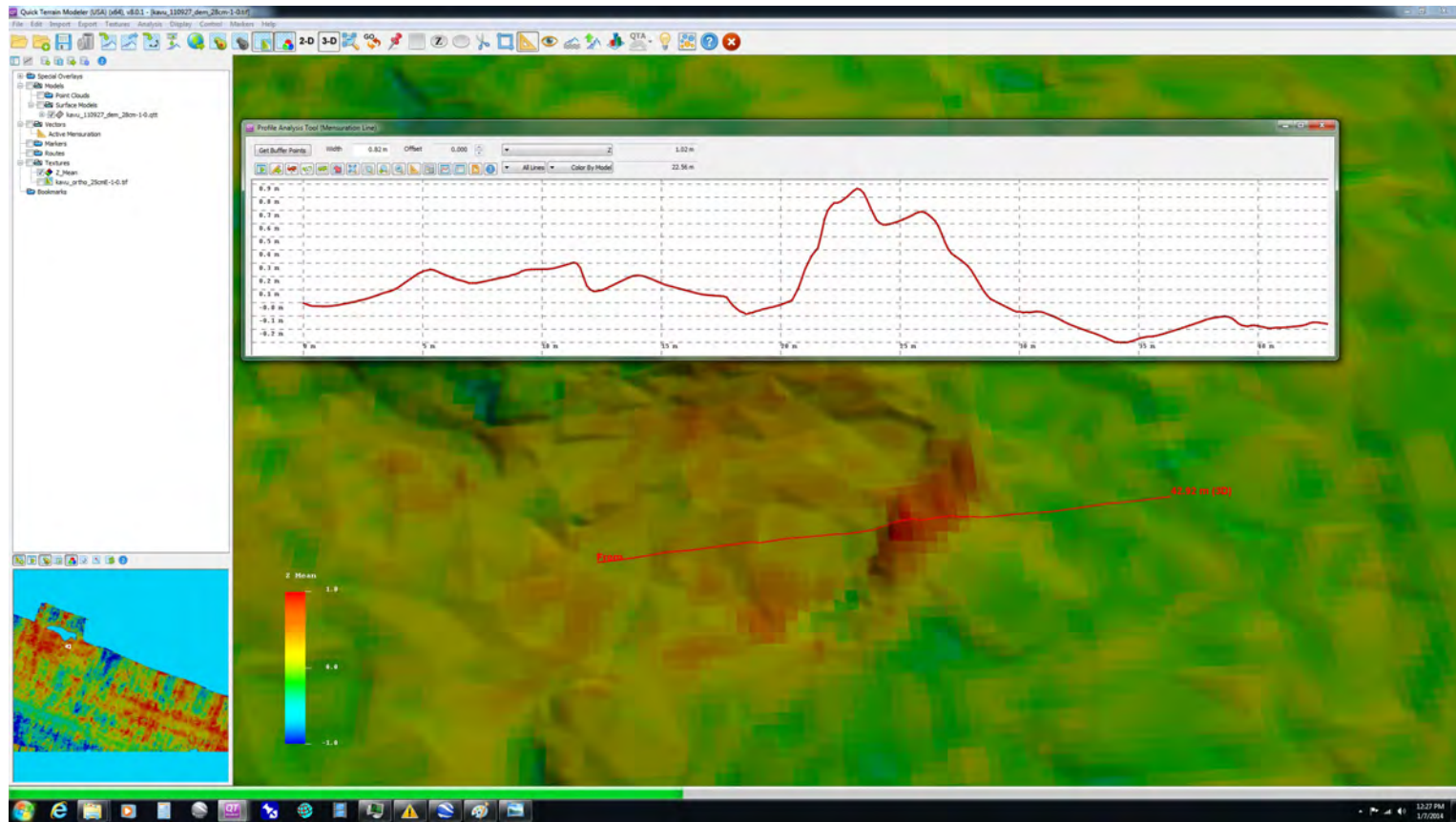




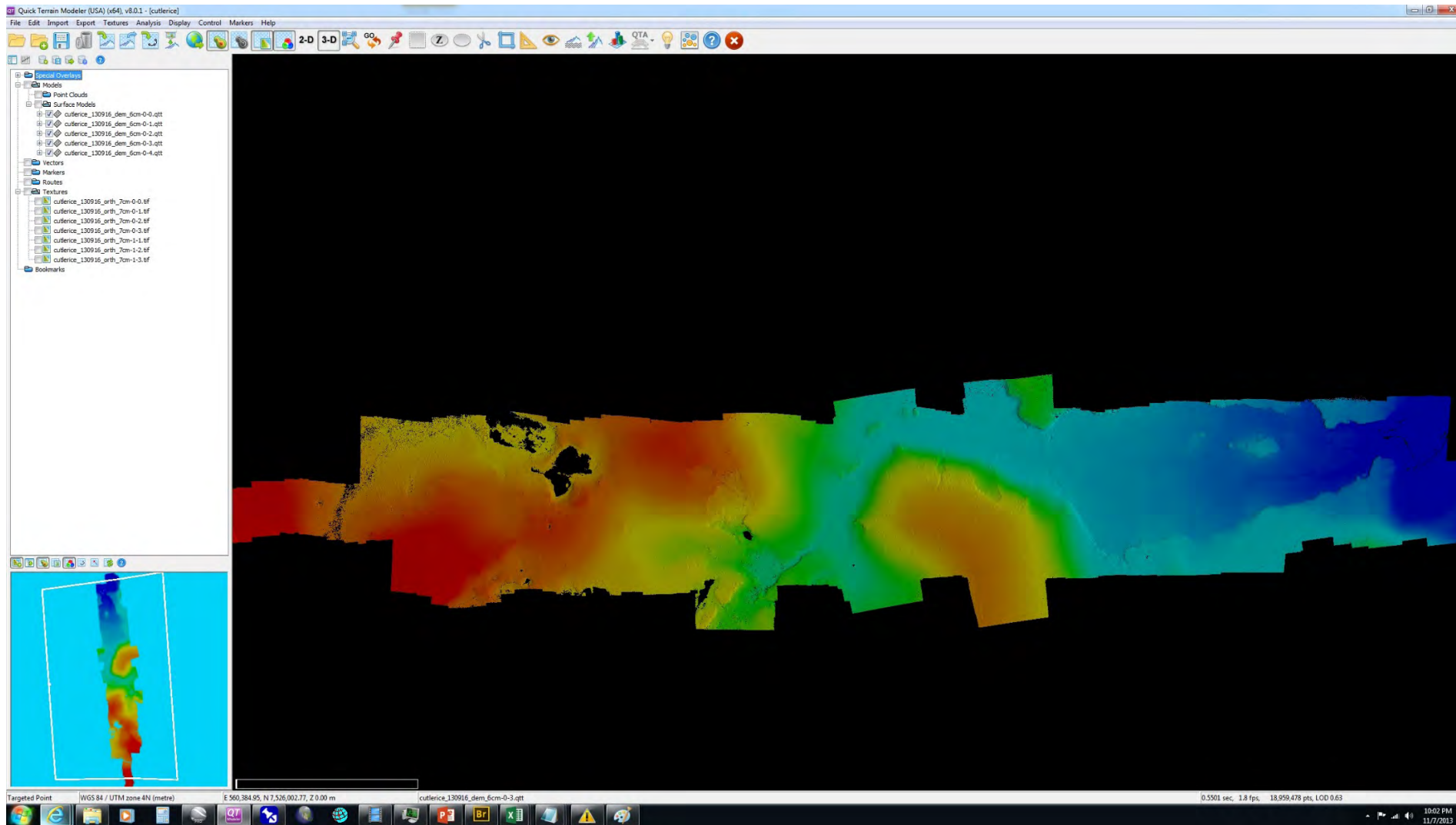
My 2013 data can be used to improve quality of 2011 data.

That the changes in headwalls are semi-circular means that no ge positioning errors have occurred and that tiny changes can be detected.

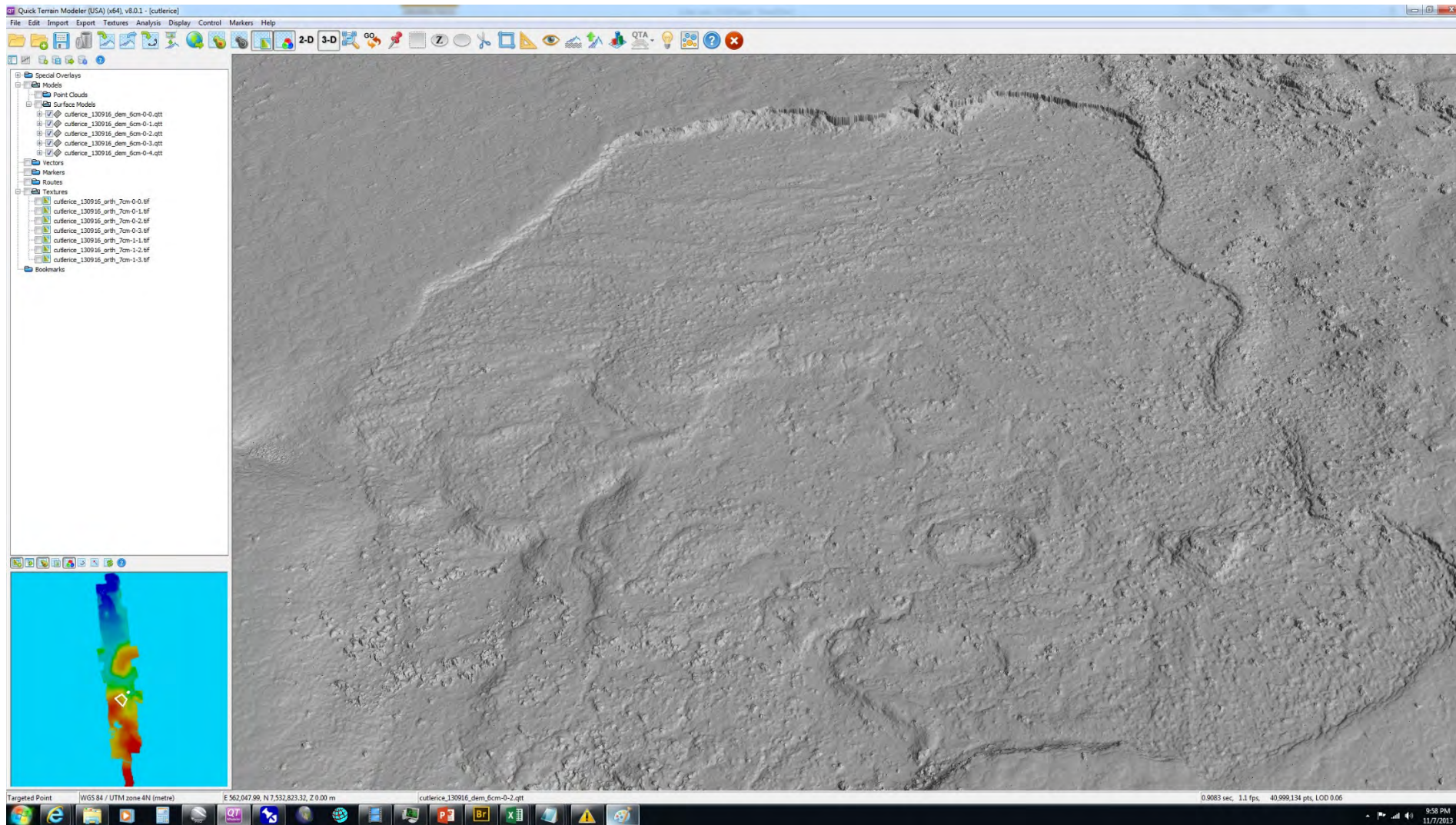


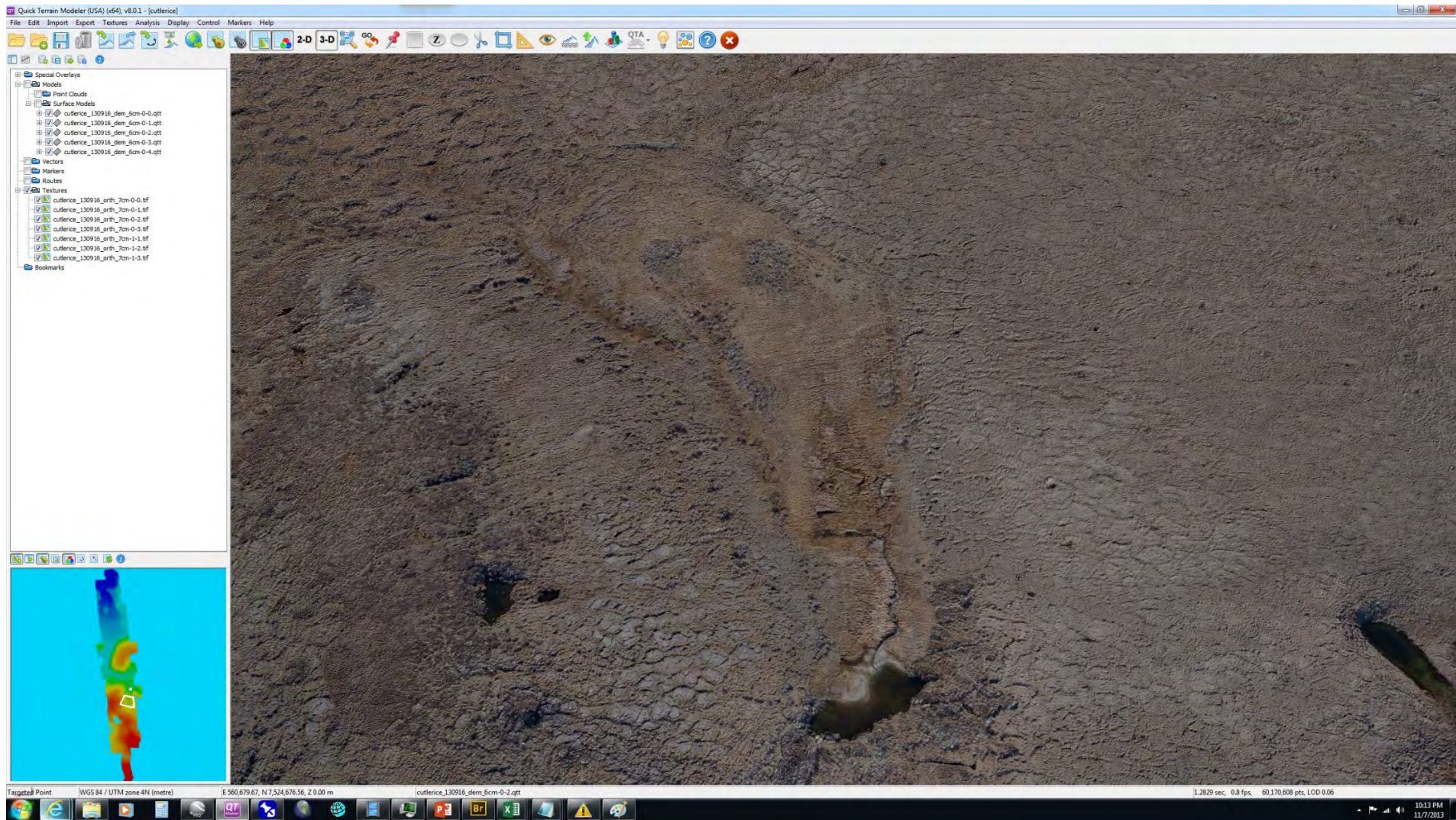


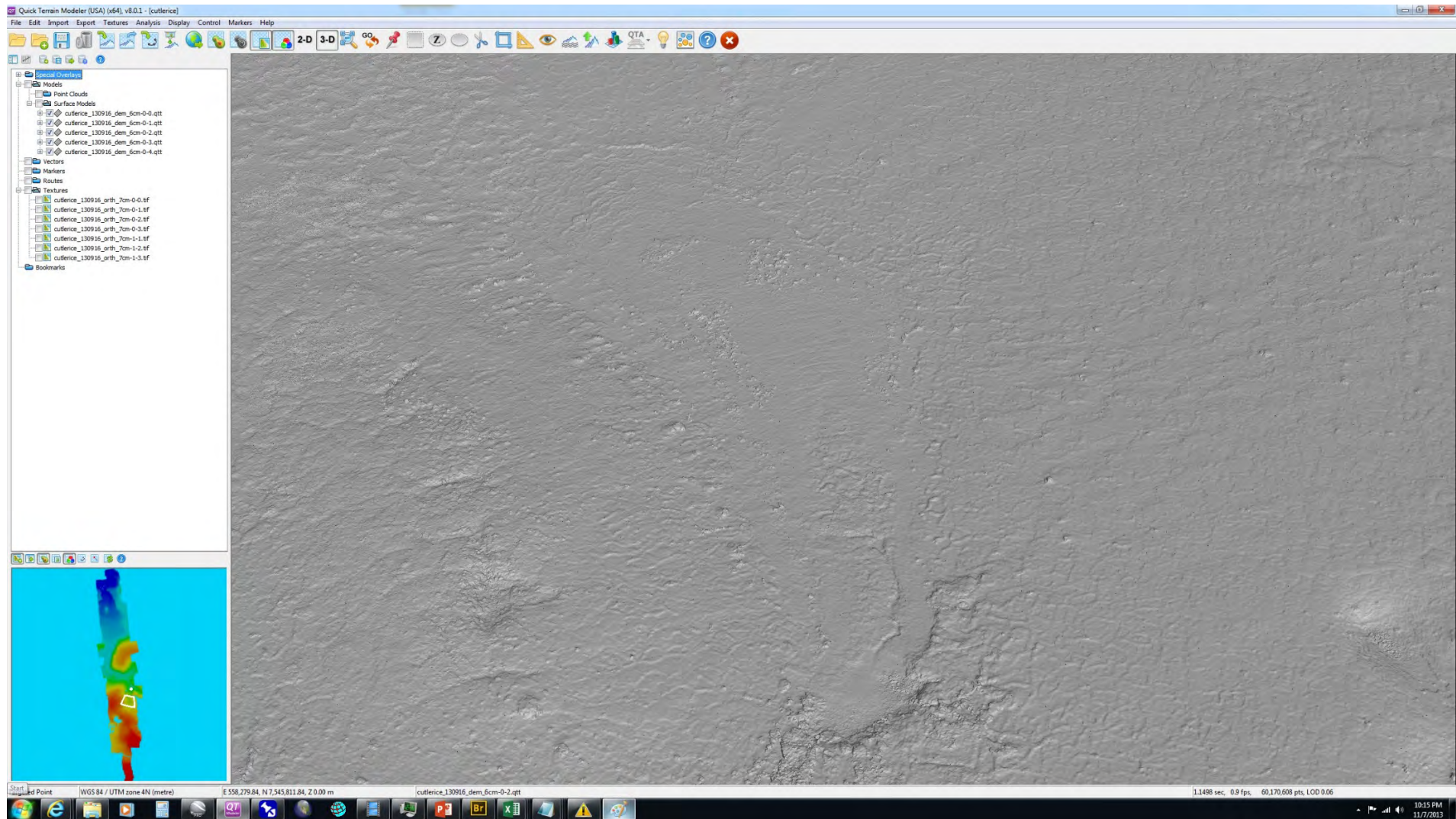


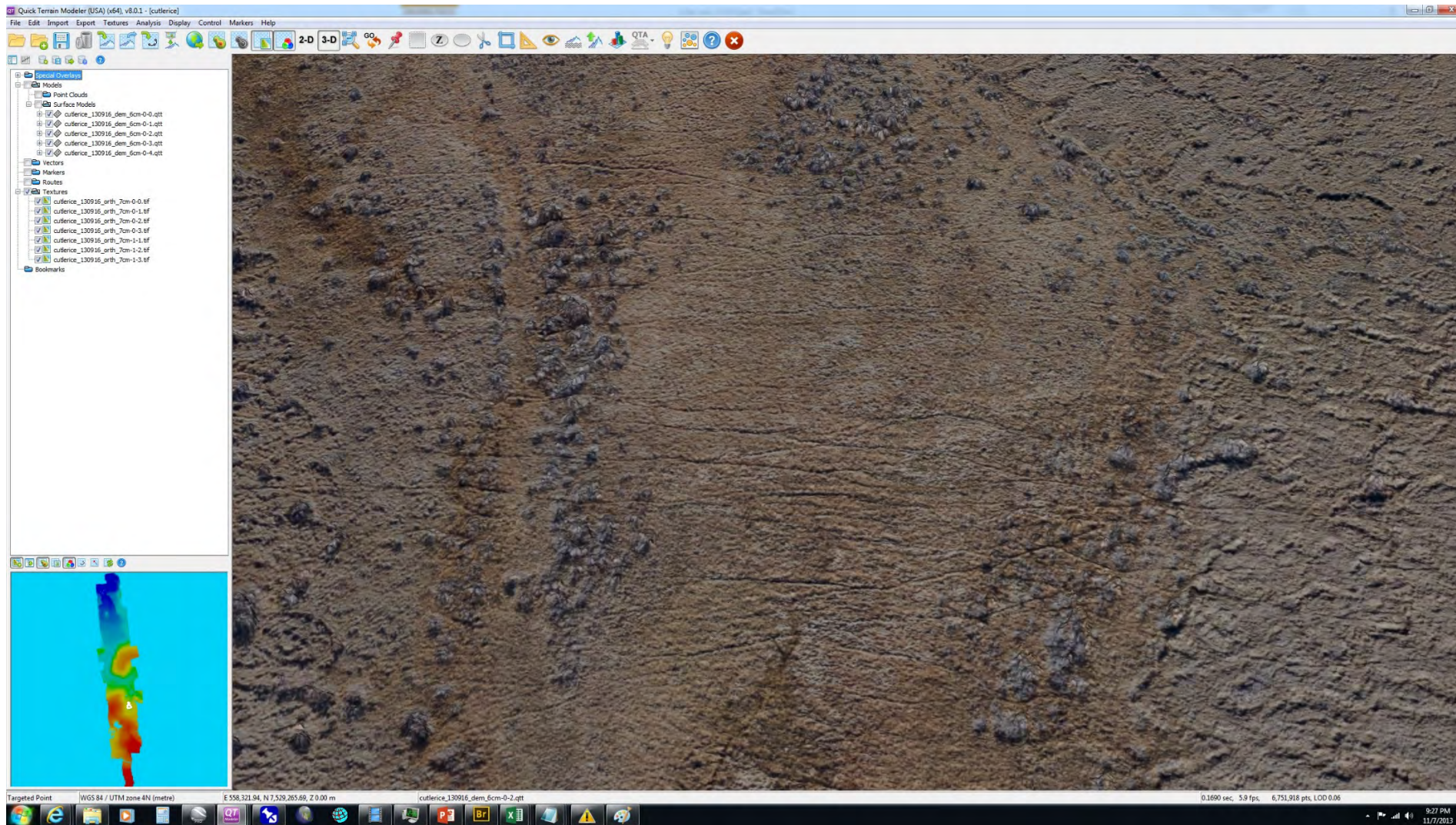


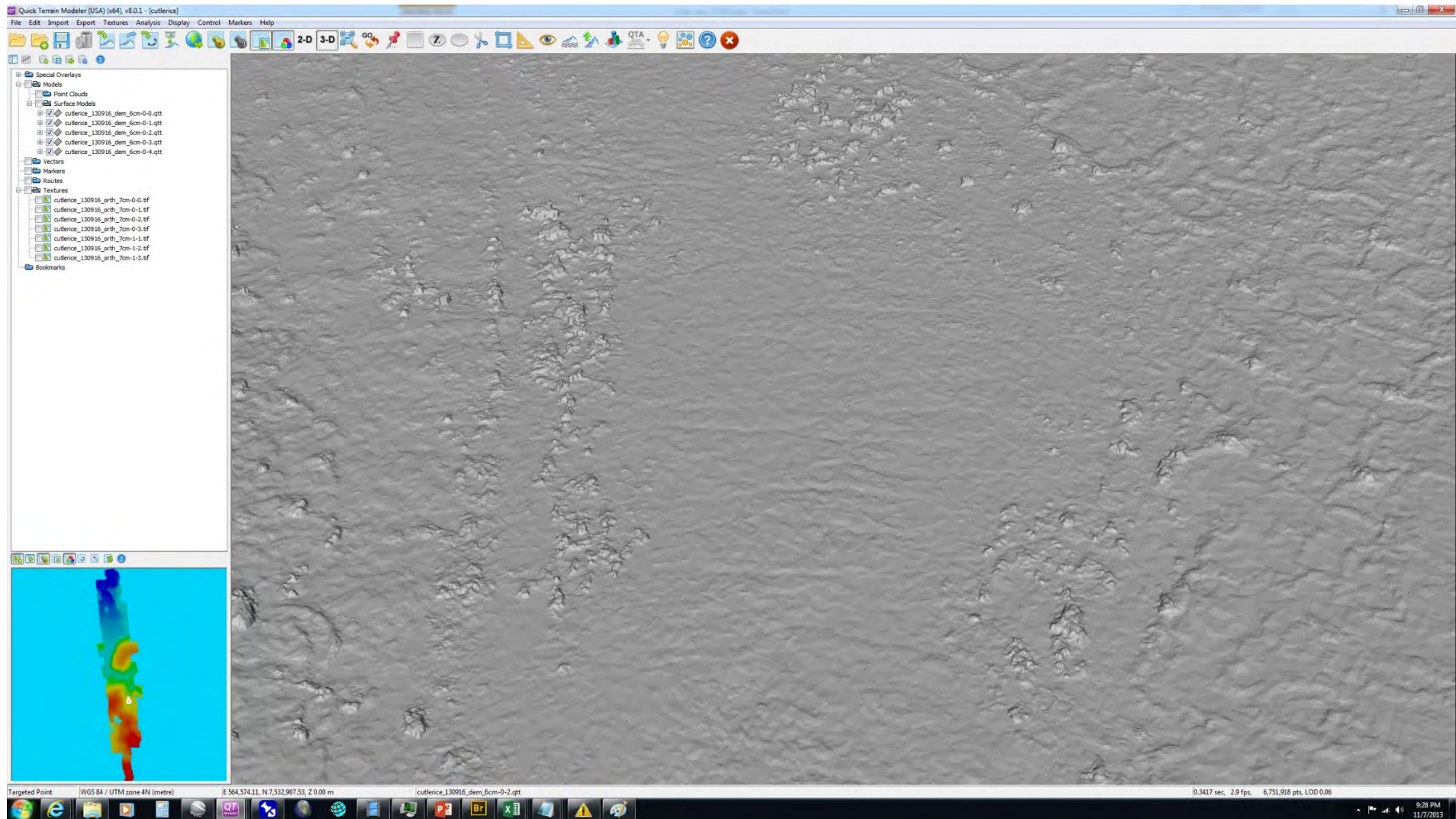




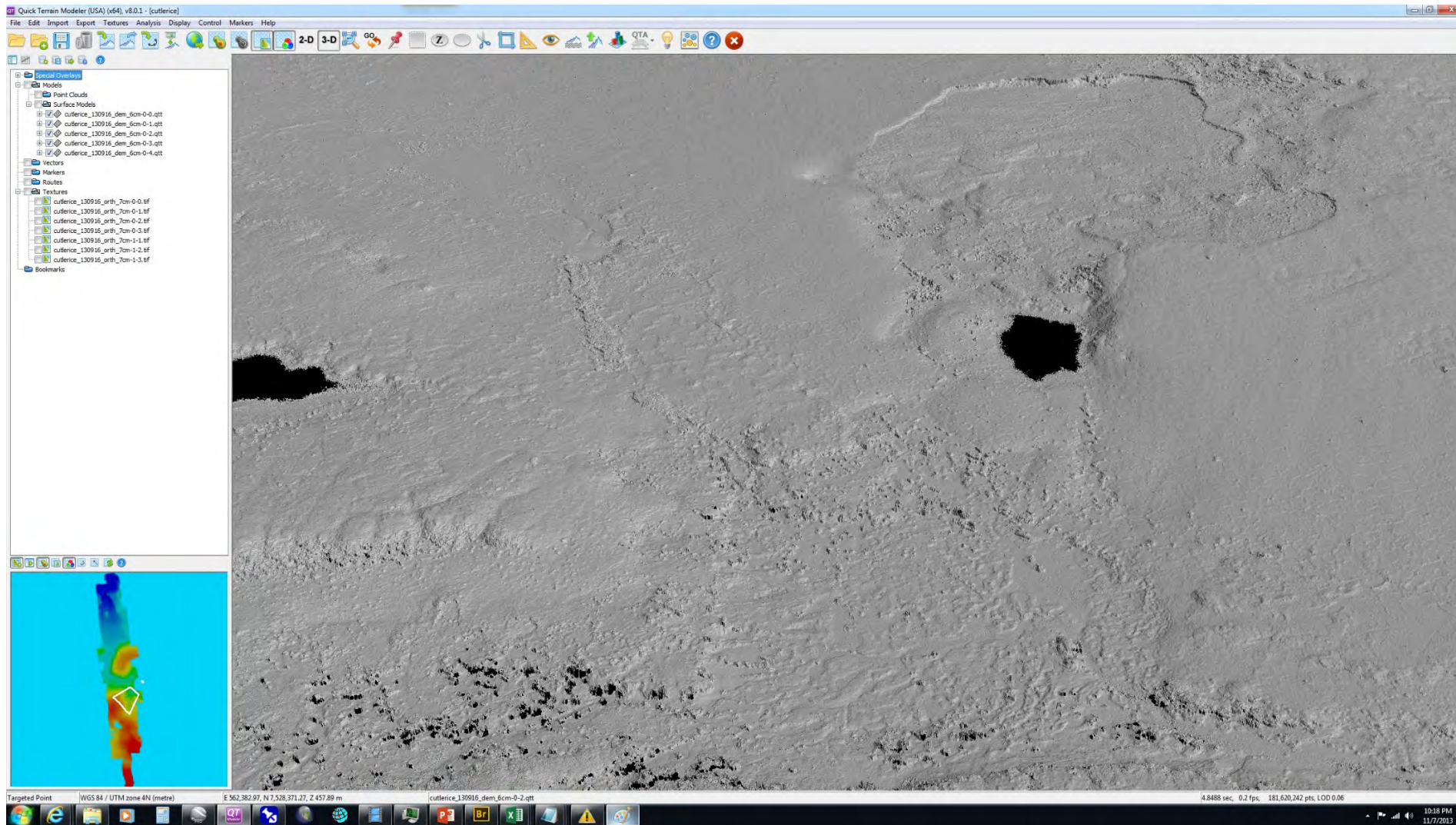


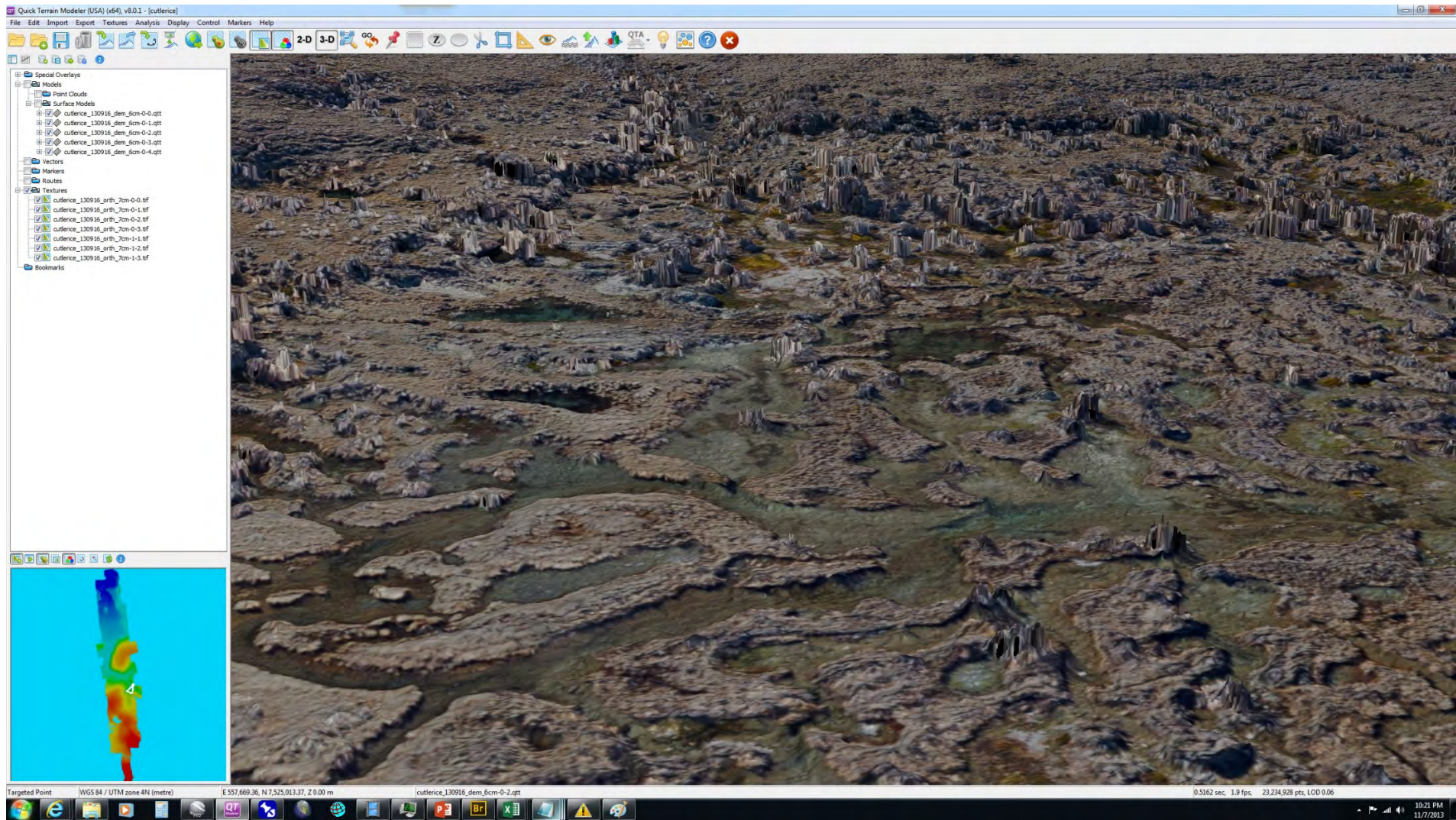


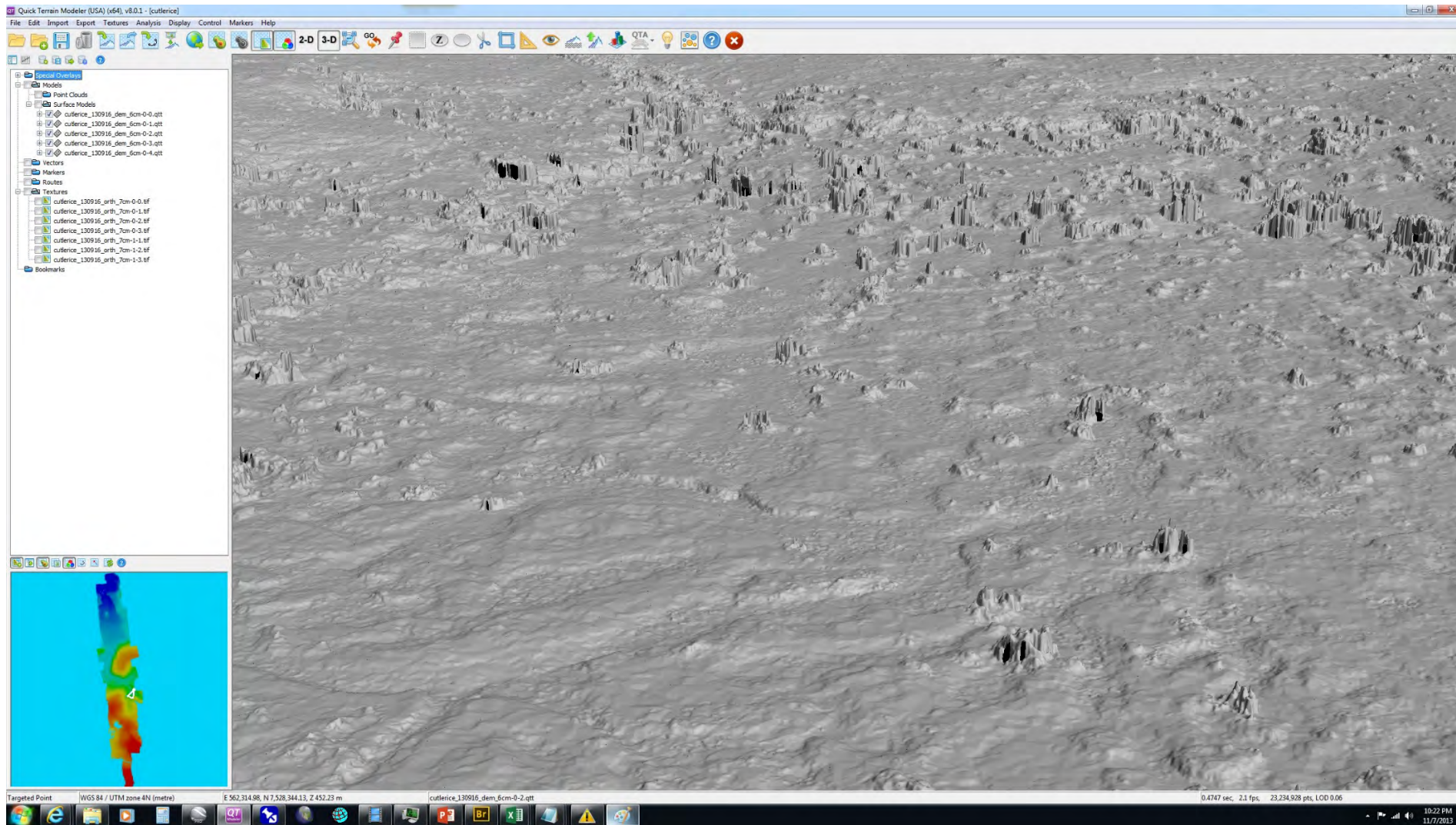




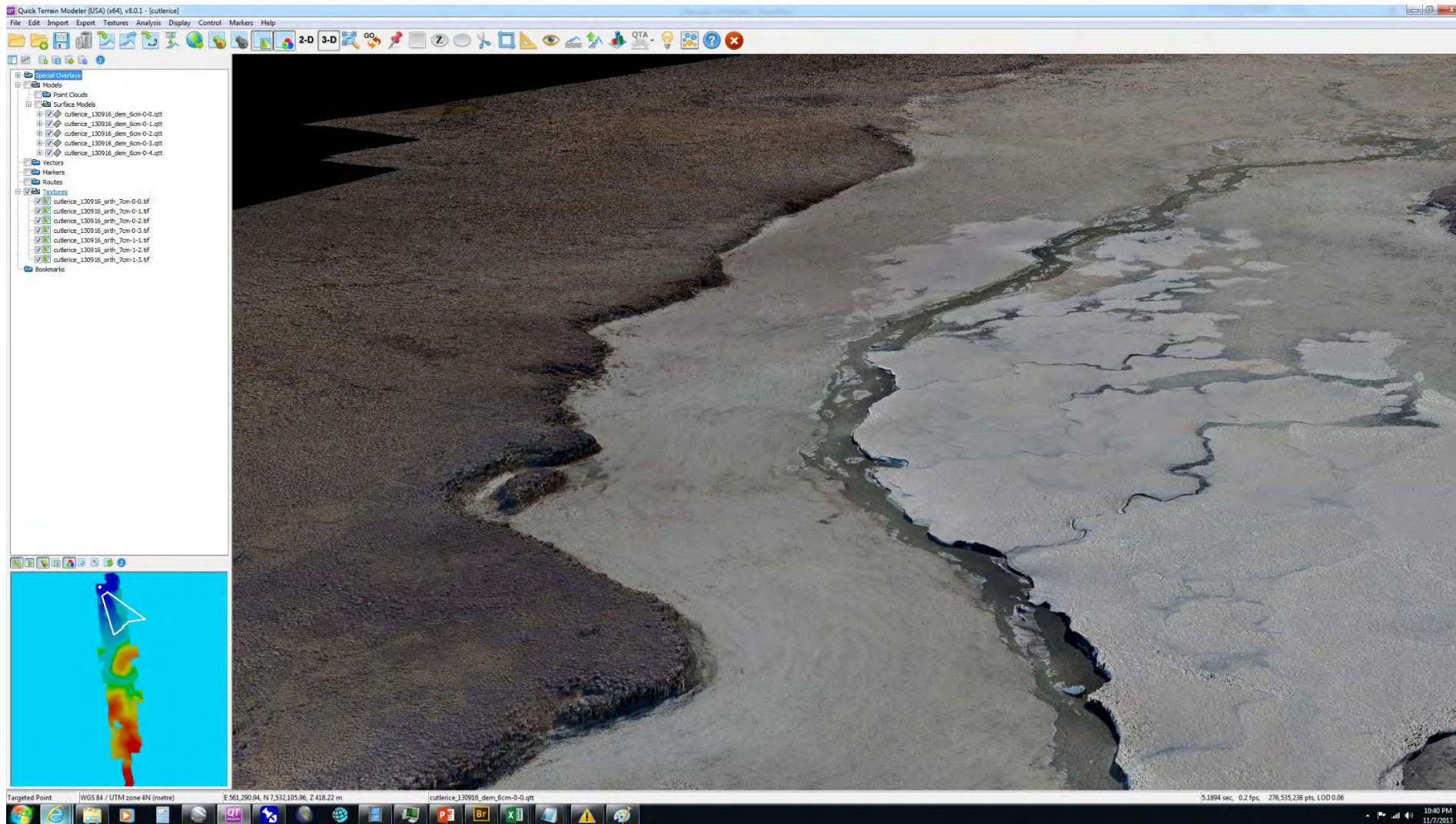


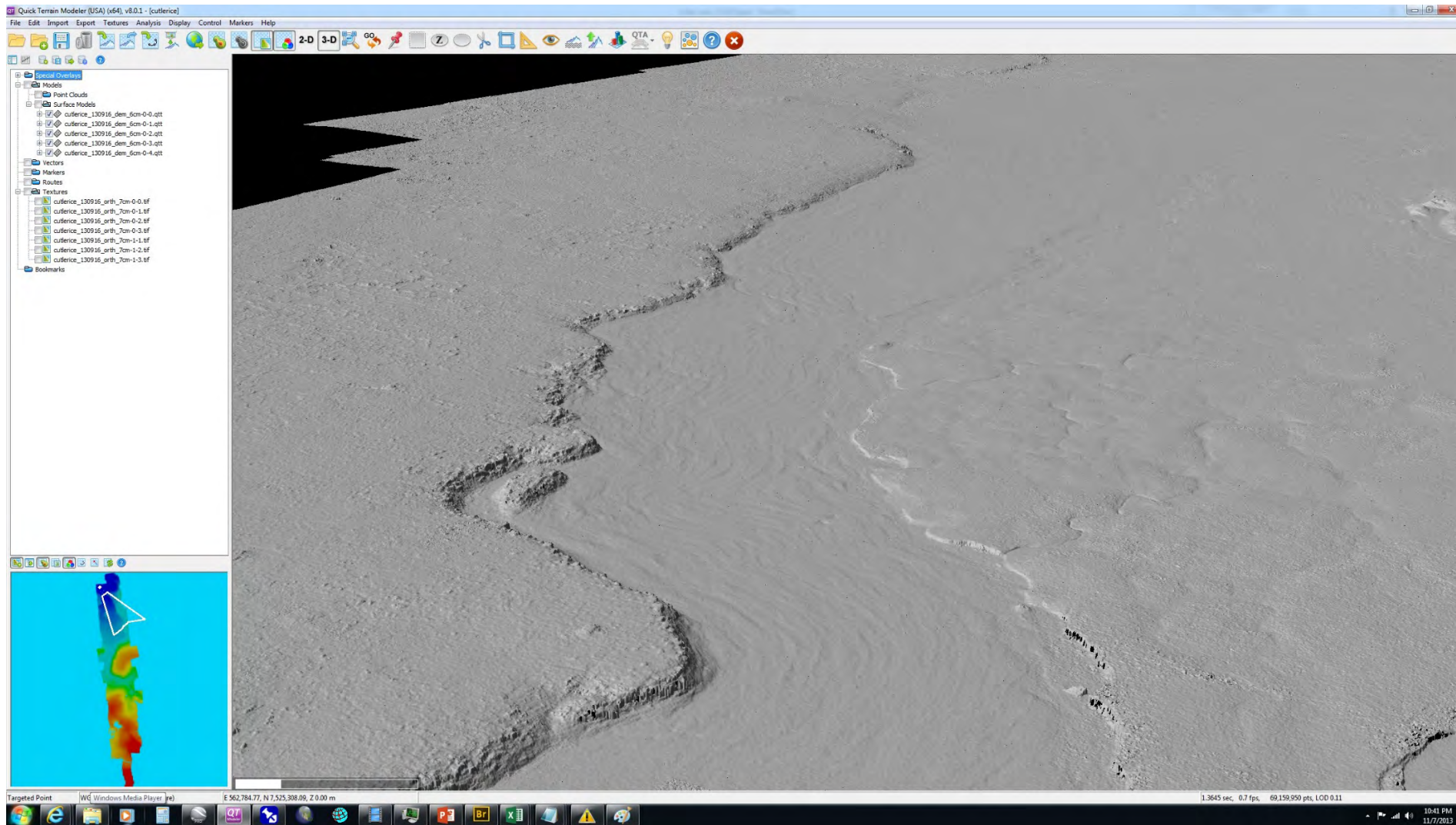






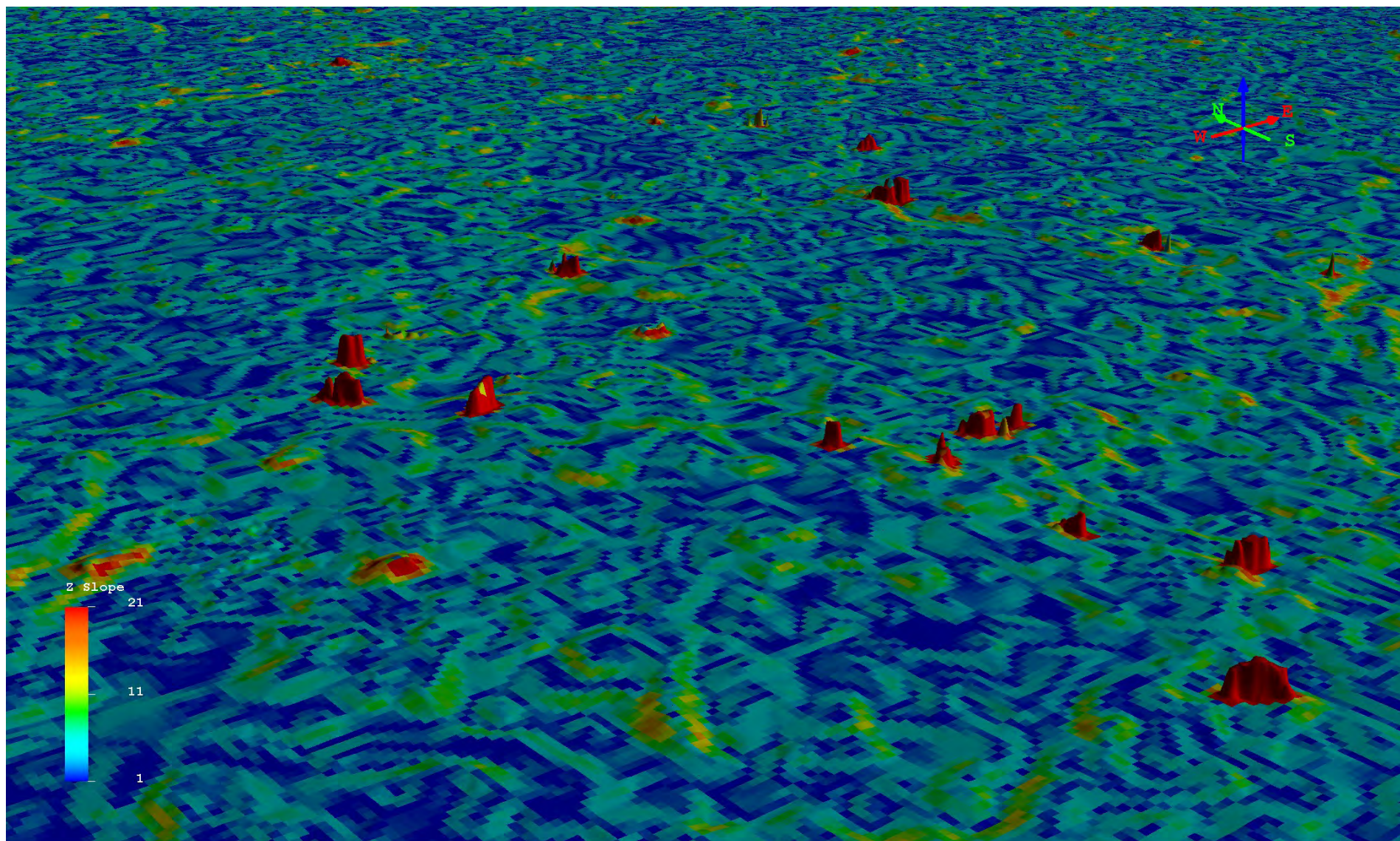


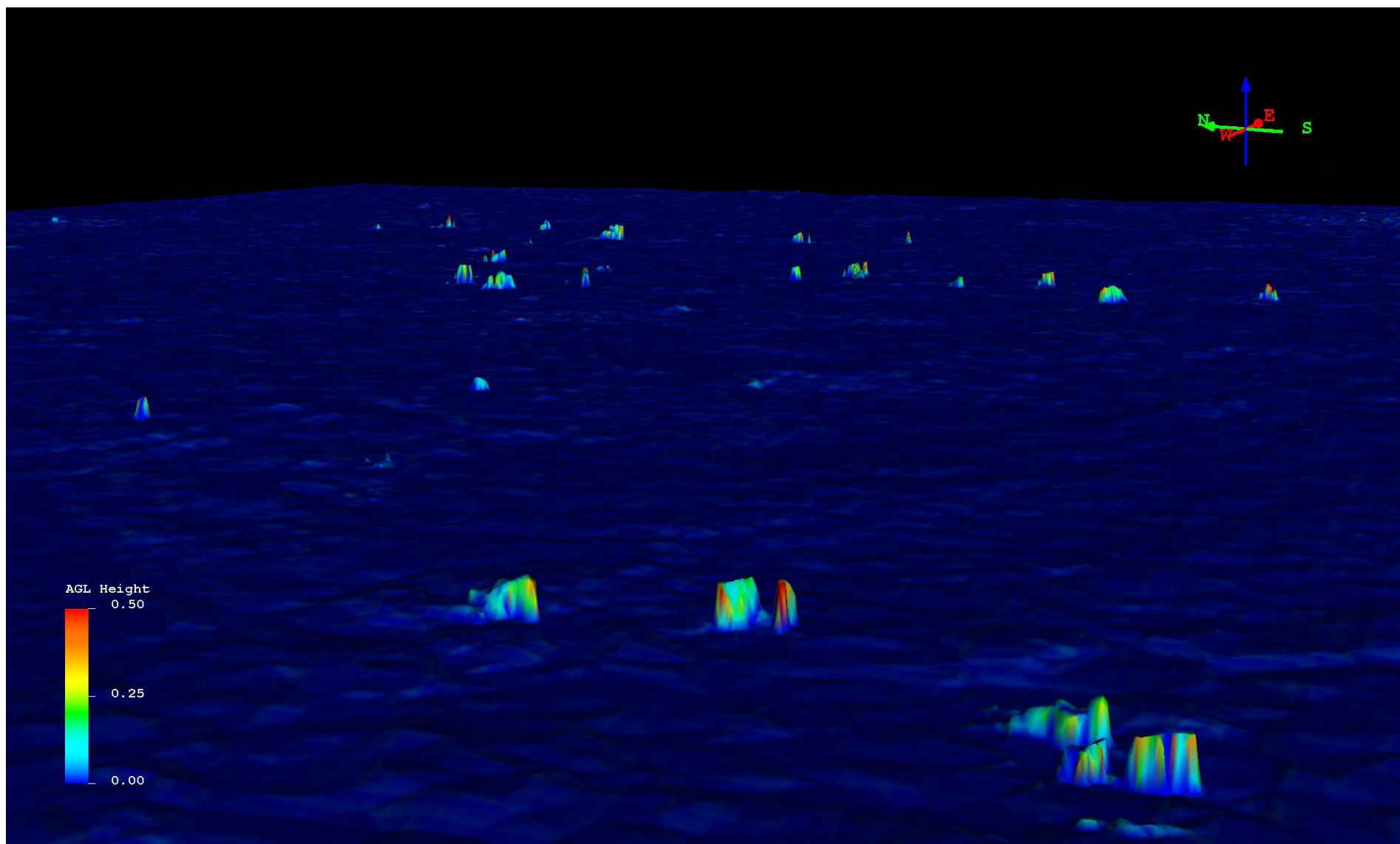


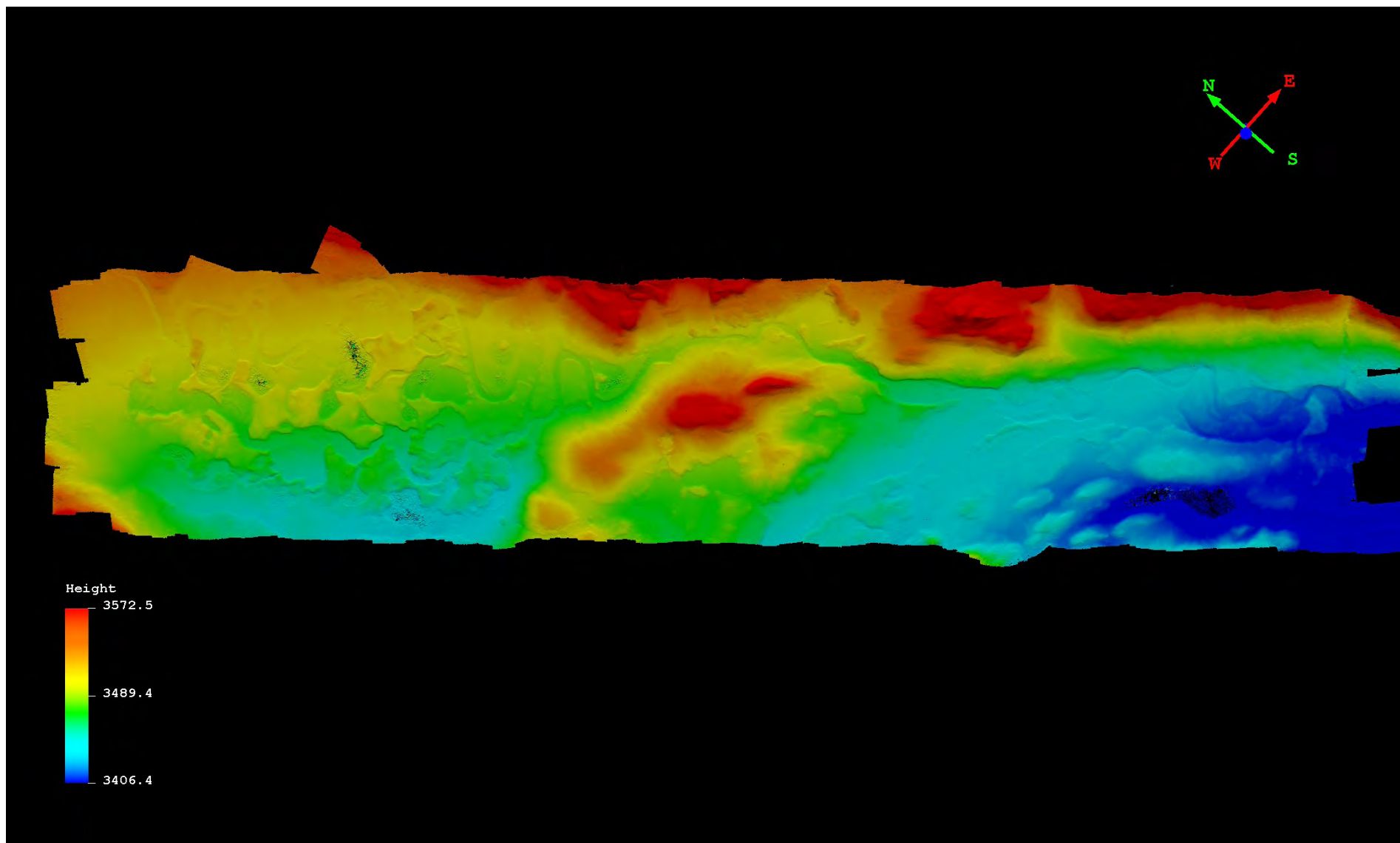


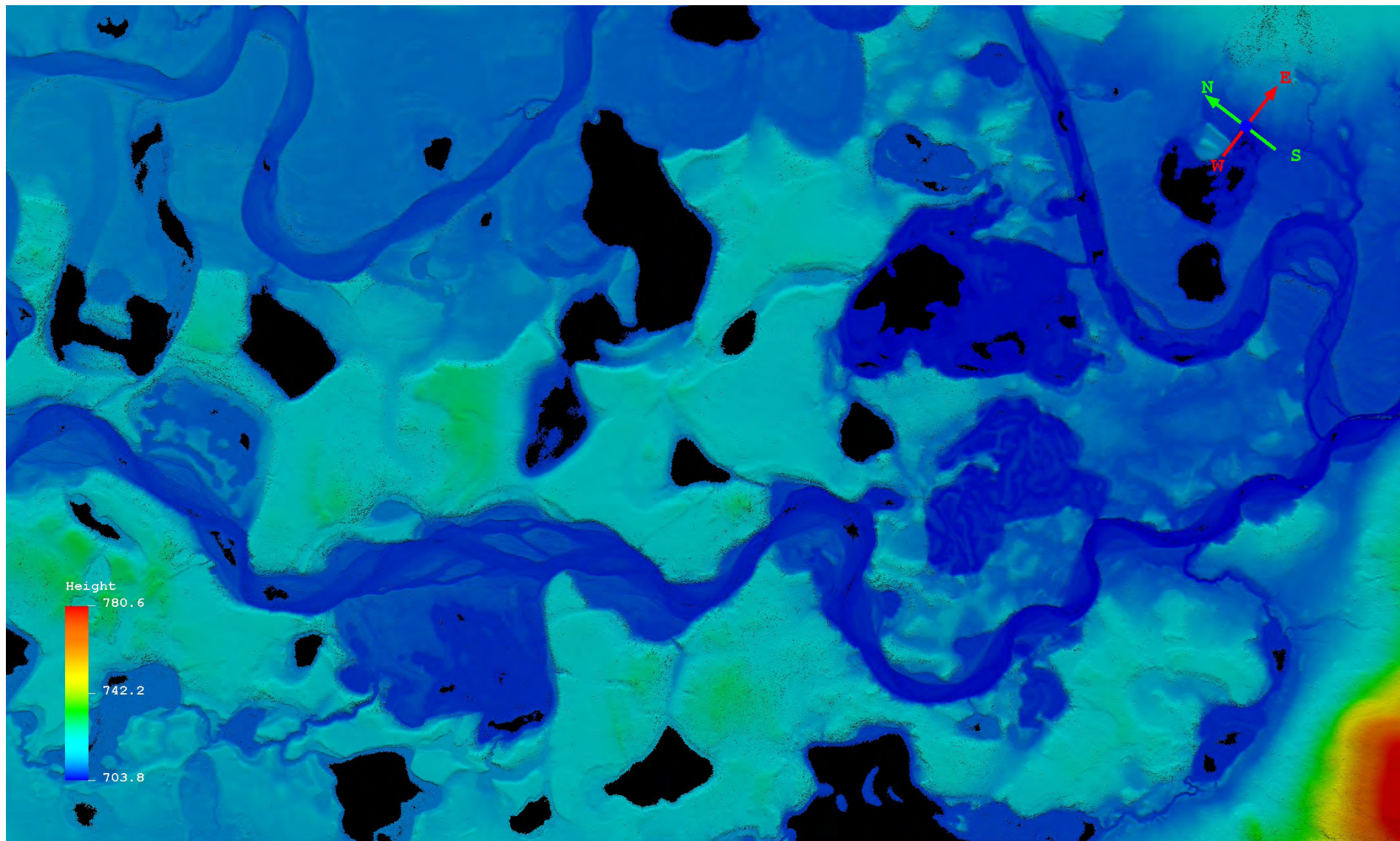


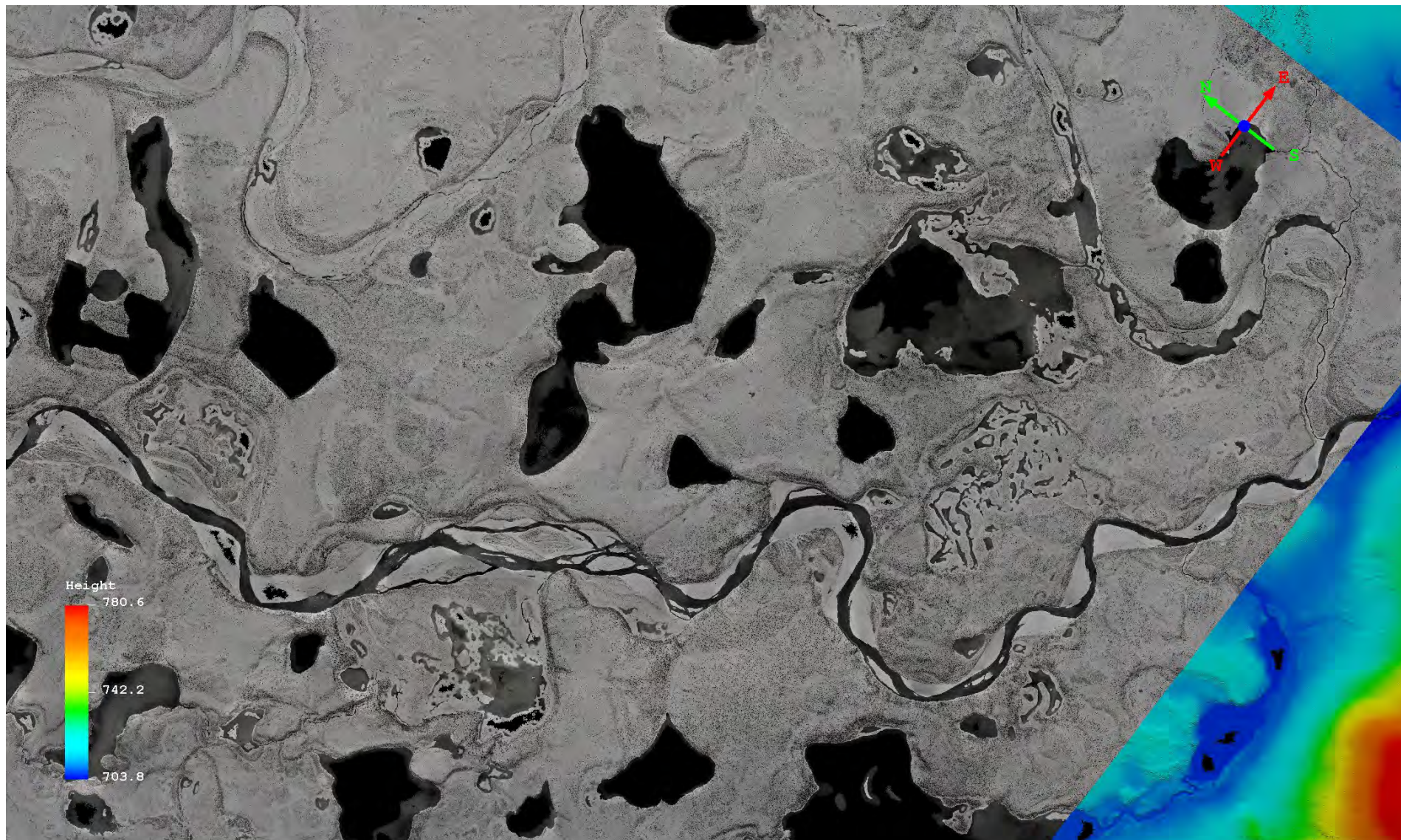




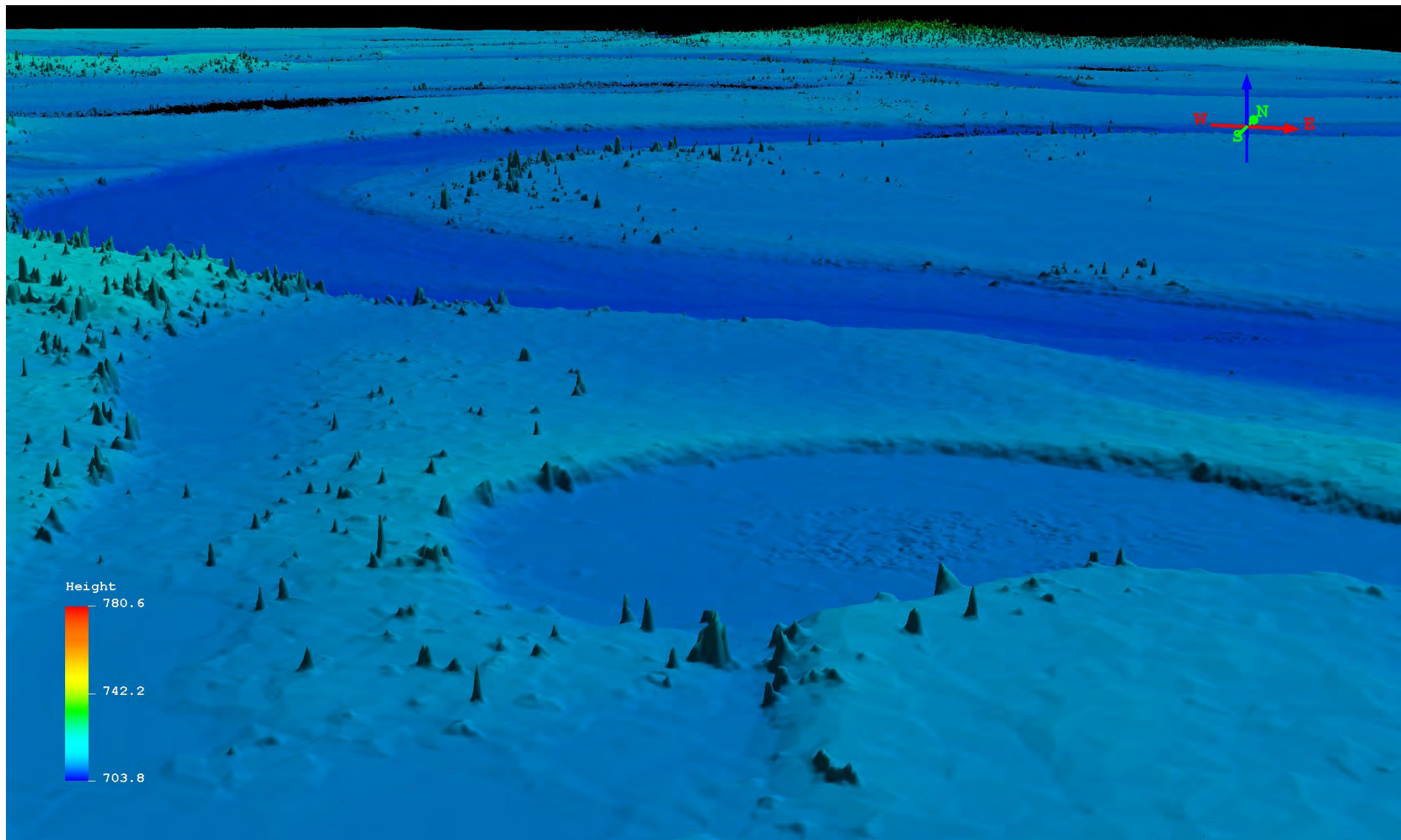


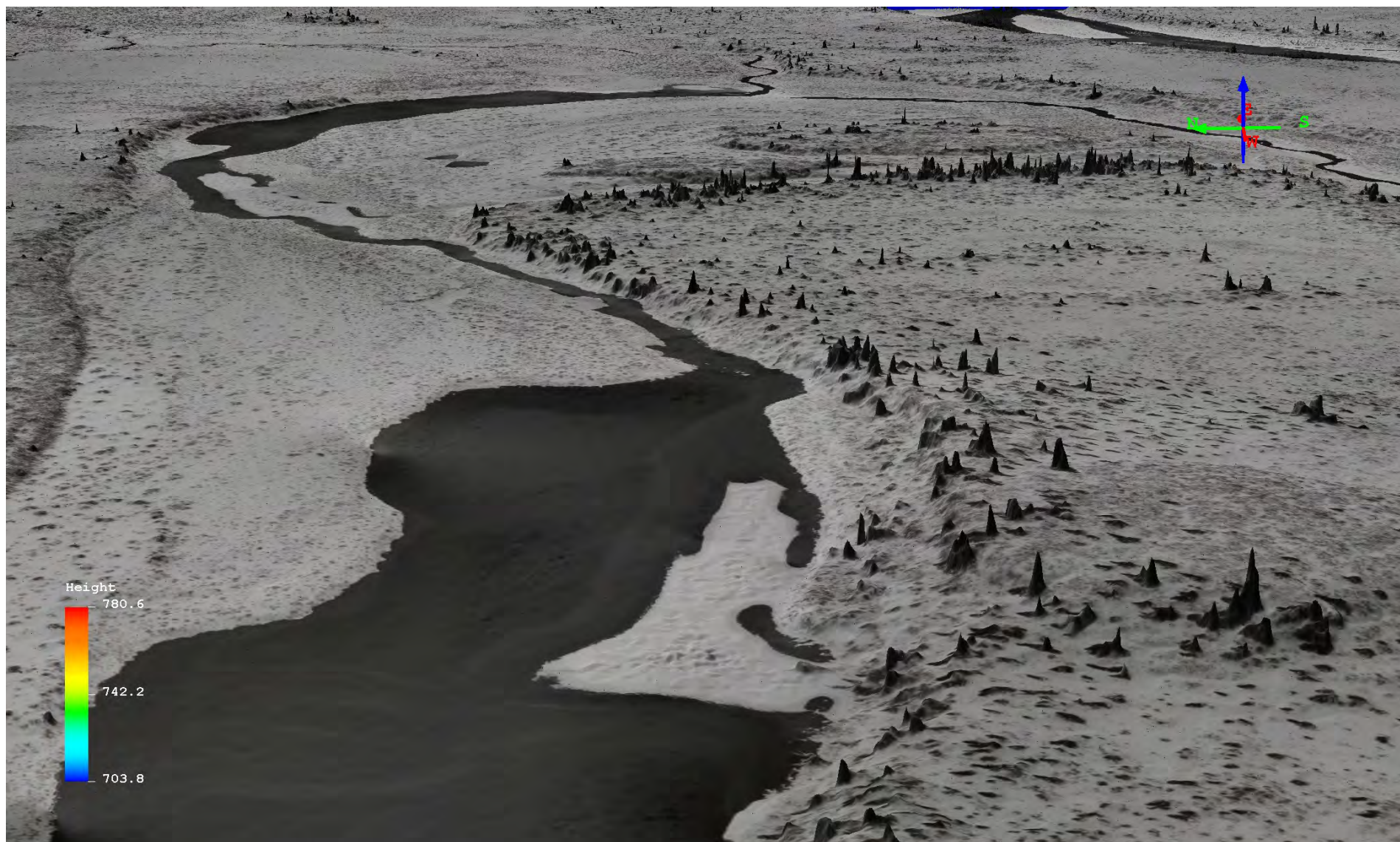


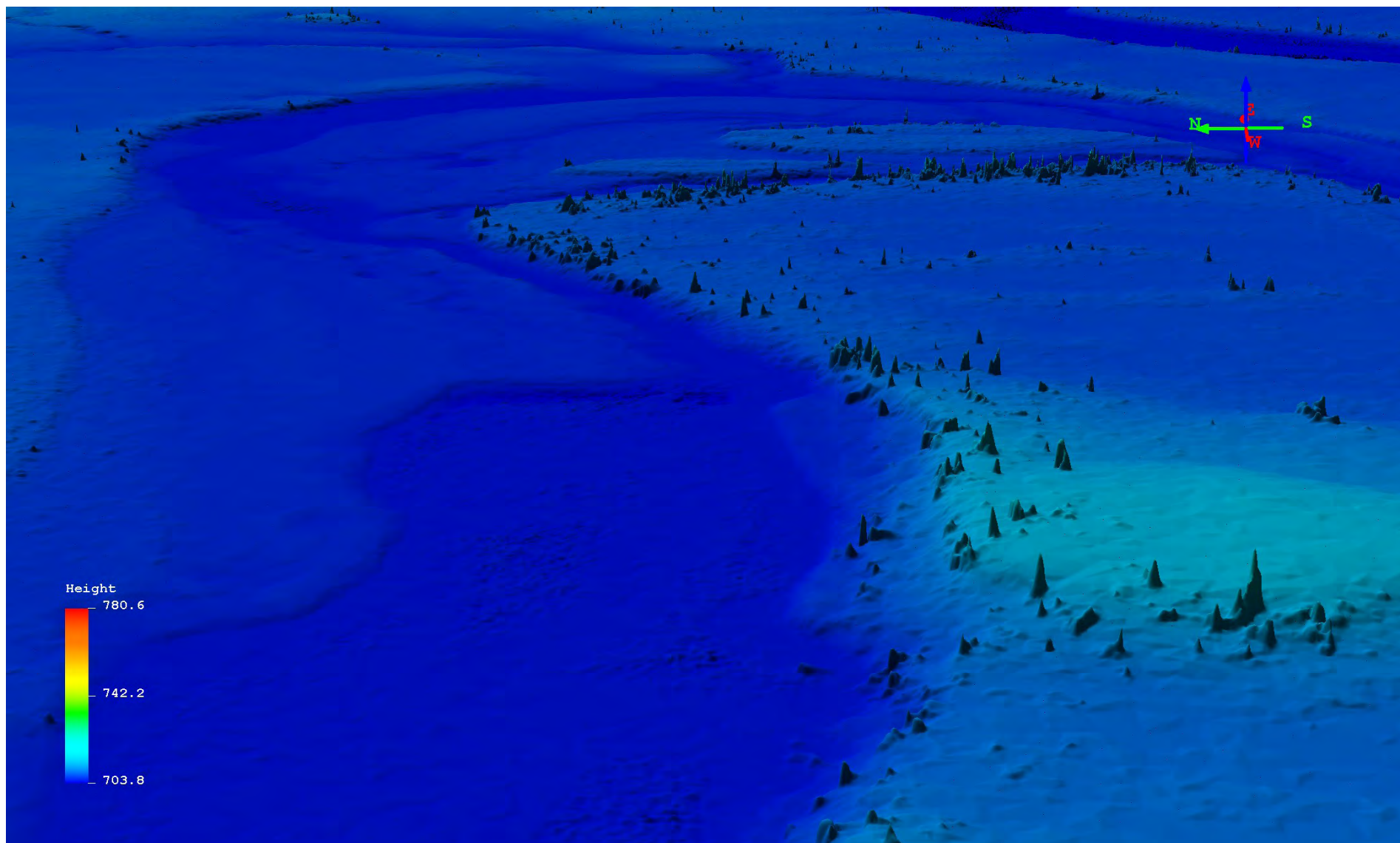


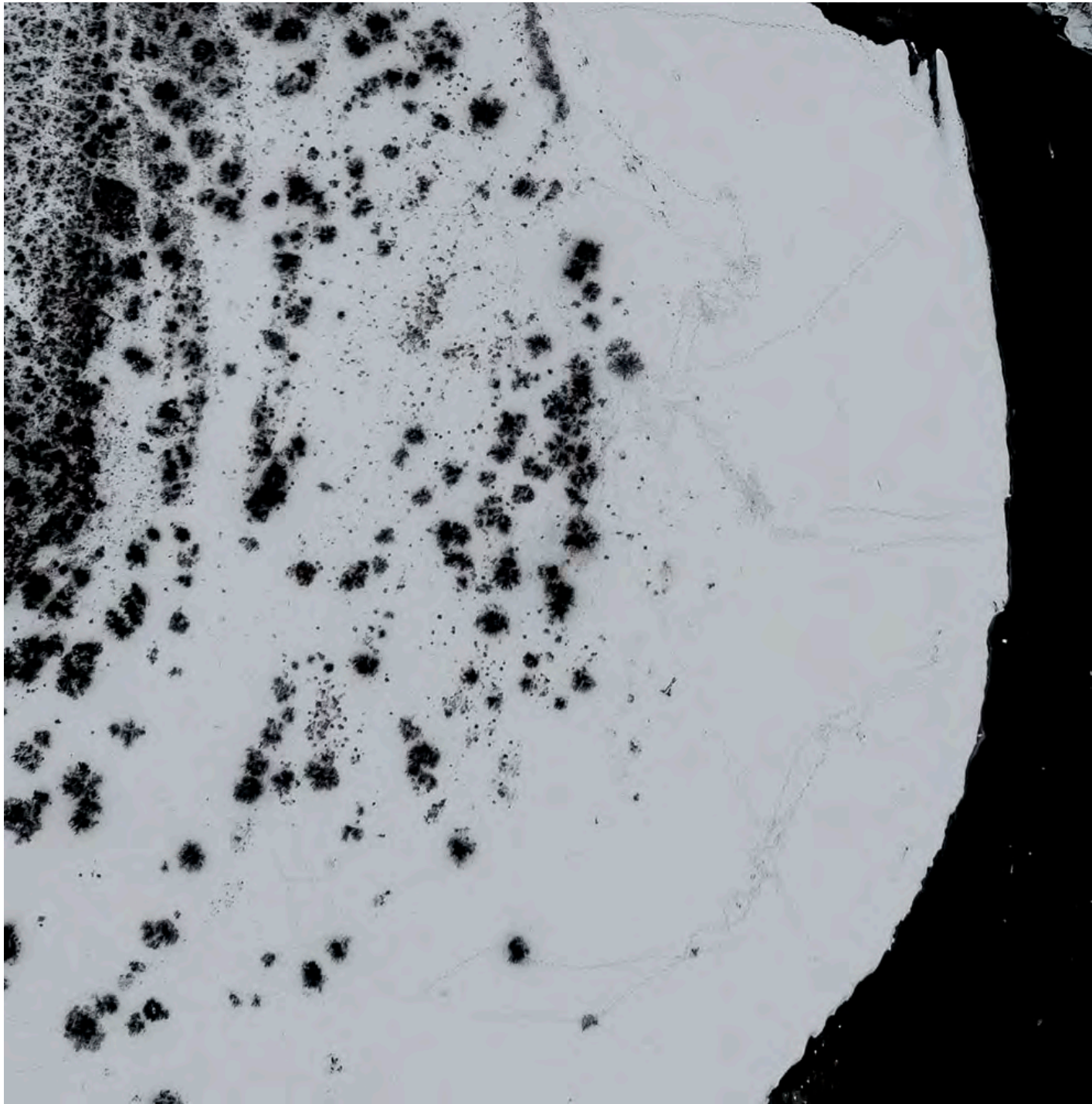




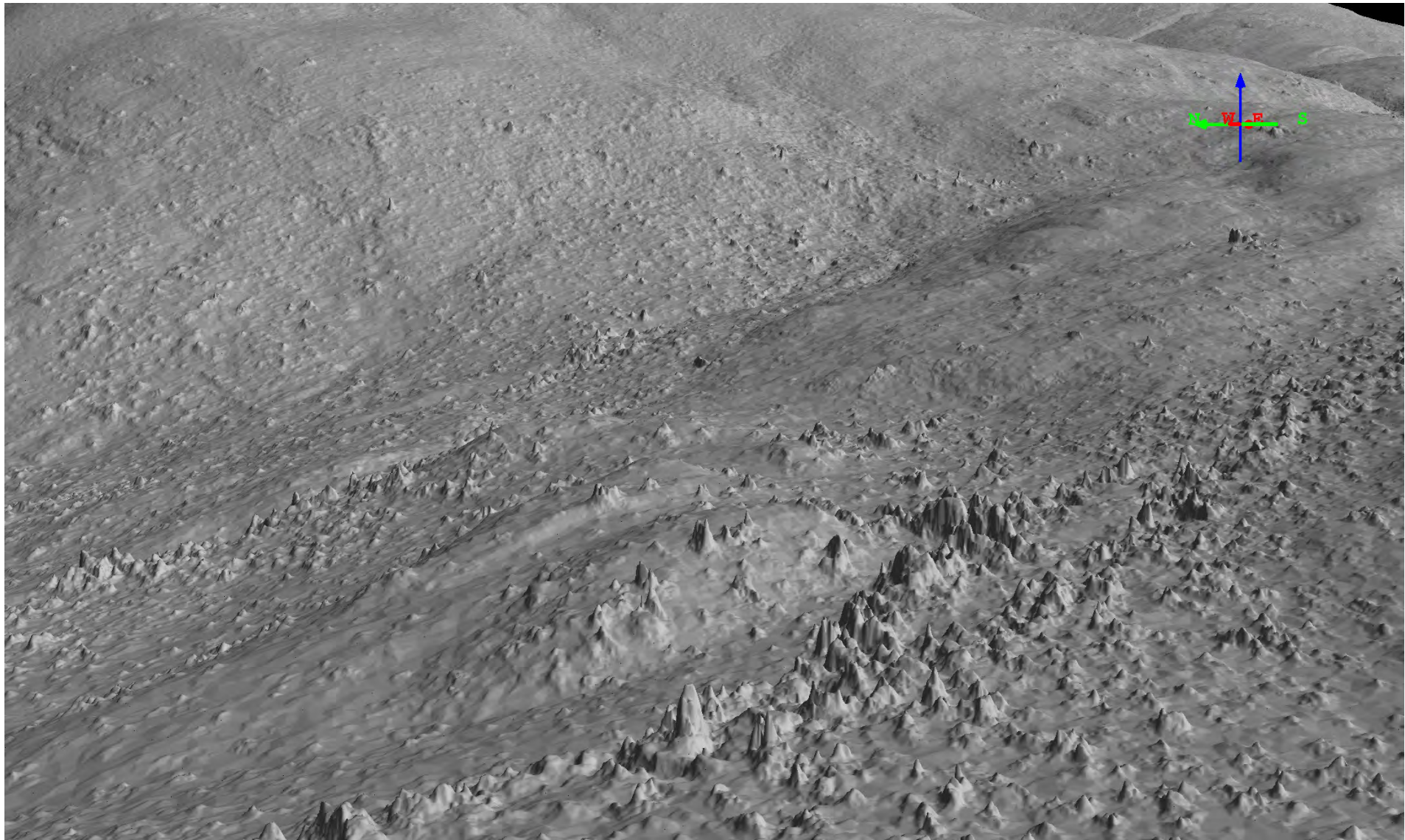












Assessment of feature resolvability

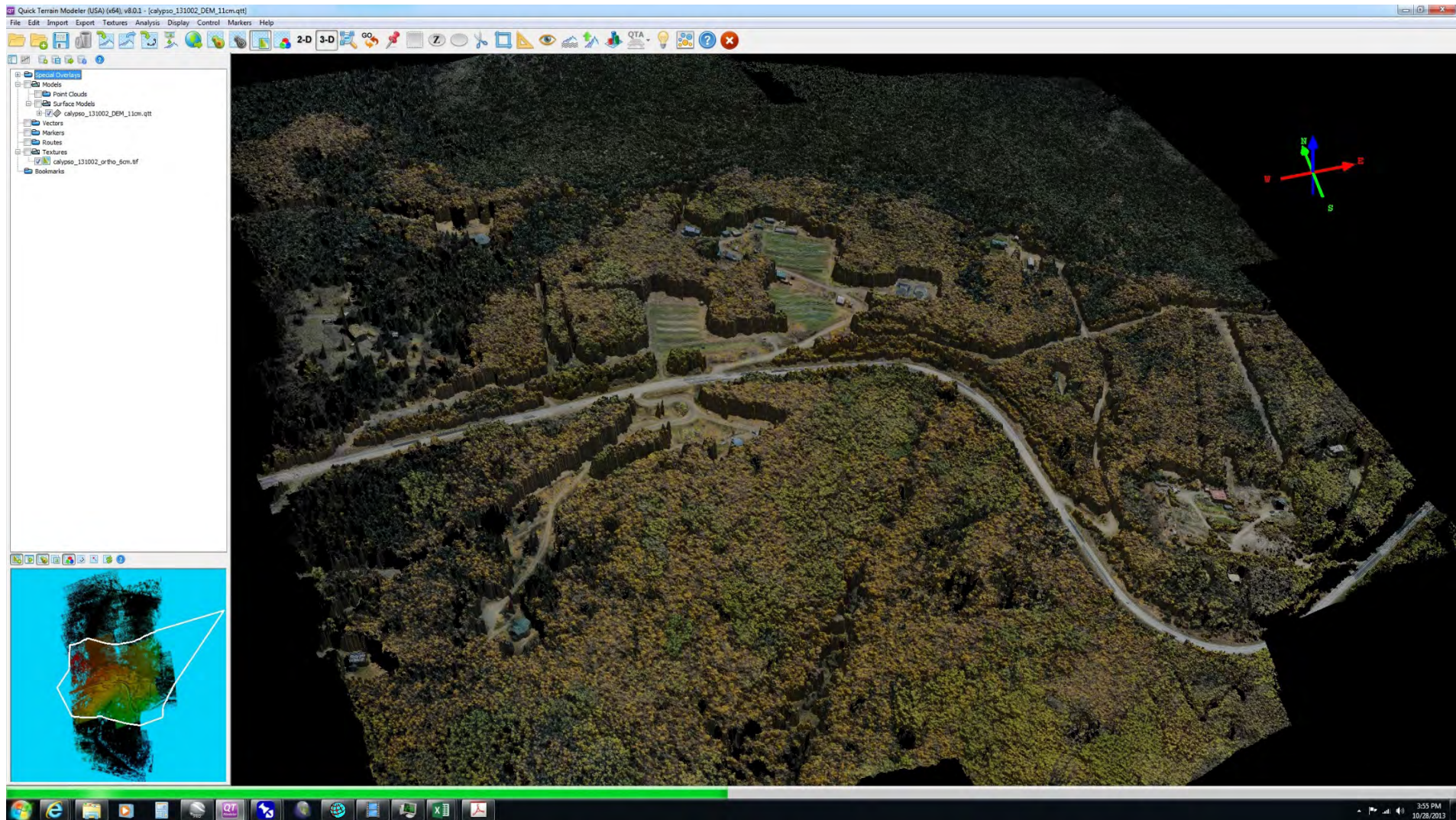


Nolan 2013: Example Photogrammetry Results

Assessment of feature resolvability

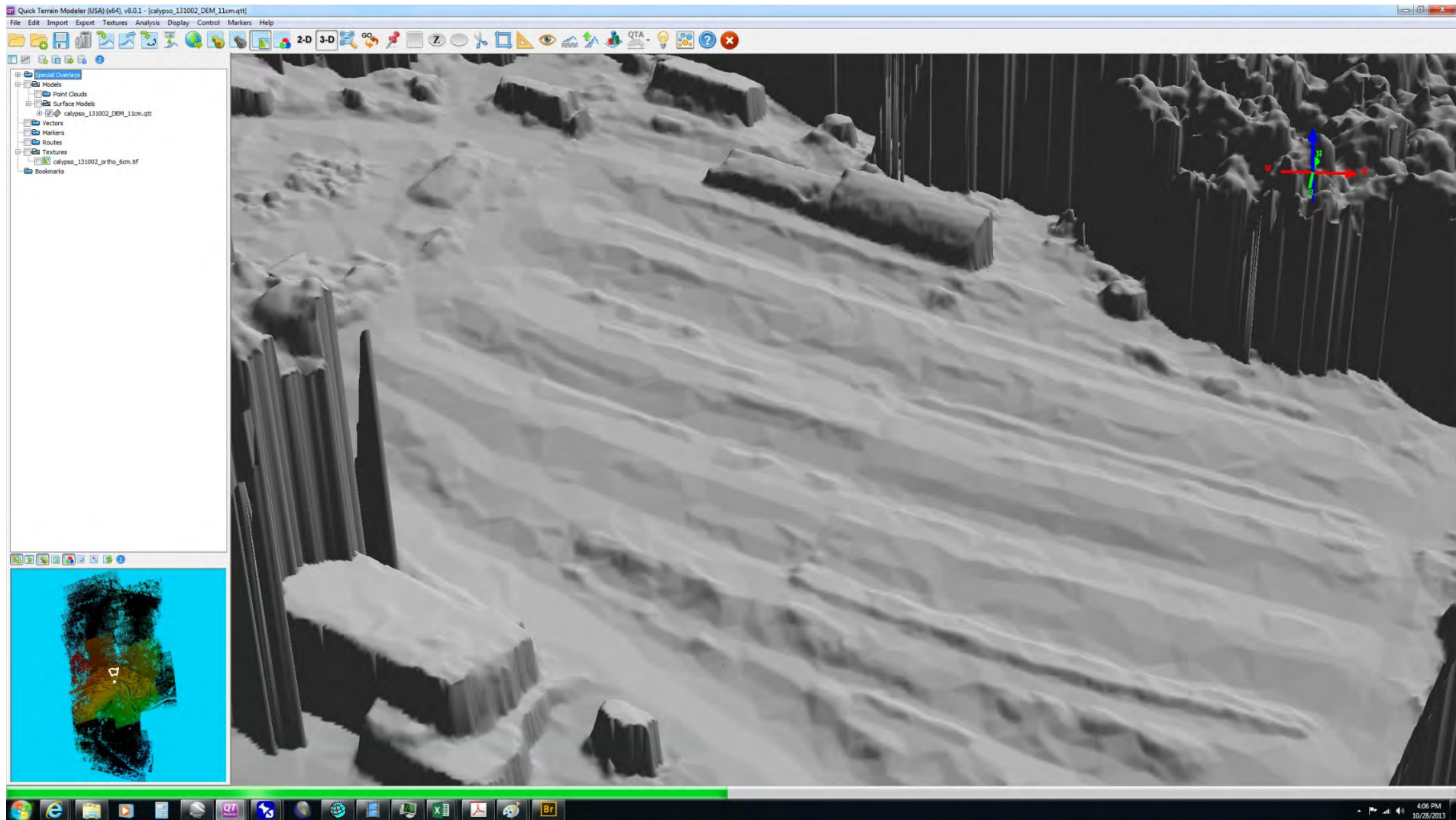


Nolan 2013: Example Photogrammetry Results











Where's Waldo Tires?



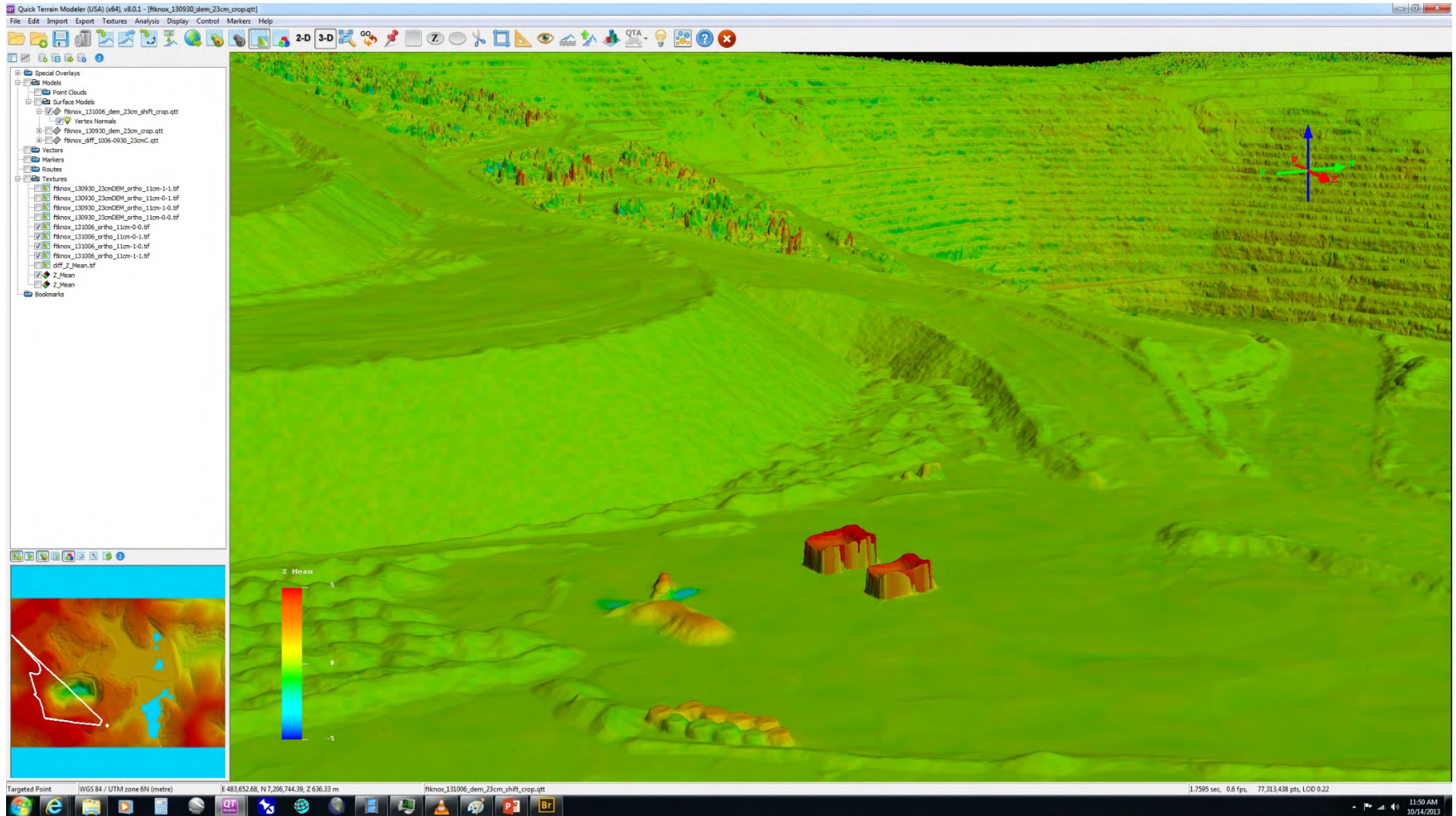
Not sure what's happening here, but two dump trucks are feeding fine grain material to a loader..

Where's Waldo Tire's?



Not sure what's happening here, but two dump trucks are feeding fine grain material to a loader..

Where's Waldo Tire's?



Not sure what's happening here, but two dump trucks are feeding fine grain material to a loader...
But I did find six of the missing tires!

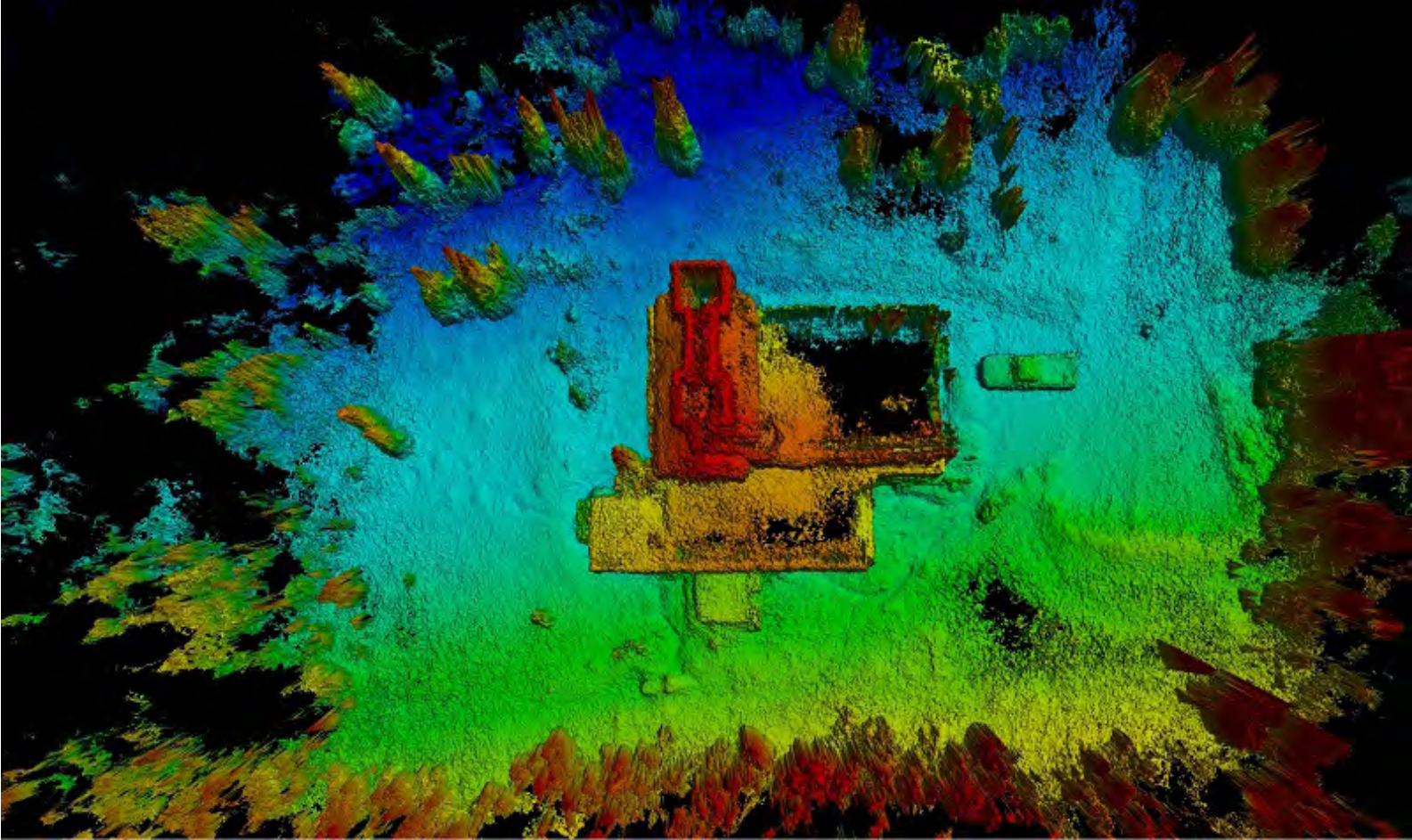
Thank you for your attention!



Learn more at www.drmattnolan.org/photography/2013
www.drmattnolan.org/photography/2014











Why does this method work and why werent we doing this 10 years ago?

- 1) Location, location, location
- 2) Massive overlap
- 3) The power to overconstrain solutions

Matt's Preliminary Assessment of Fodar

Fodar: The art and science of measuring distance using workflows designed for digital photography

Advantages of fodar over lidar:

- It is higher resolution (all else equal)
- It is just as accurate and precise, if not more so
- It yields a perfectly coregistered orthophoto
- Hardware is significantly cheaper (10x -1000x) and therefore affordable
- Hardware, software, and methods are rapidly evolving and easily implemented

Disadvantages:

- It takes more operator skill and expertise to plan and acquire
- It takes more CPU time to process
- It requires parallax images – moving targets or shadowing/layover challenging
- Commercial infrastructure hasn't caught up yet

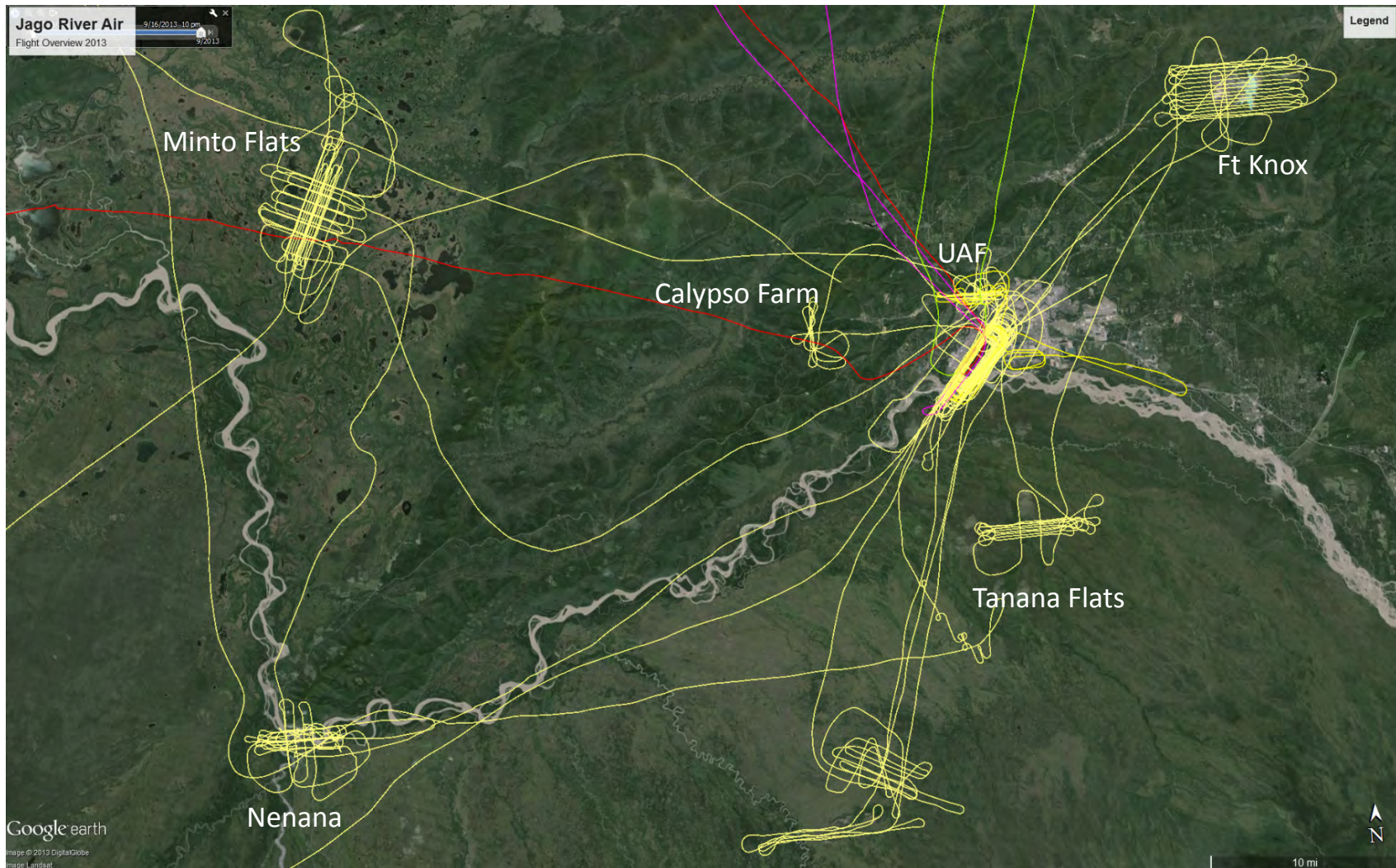
Matt's Preliminary Assessment of Fodar

Because of the reduction in cost, we now have the opportunity to study *change* of most of the earth's surface at unprecedented detail and frequency

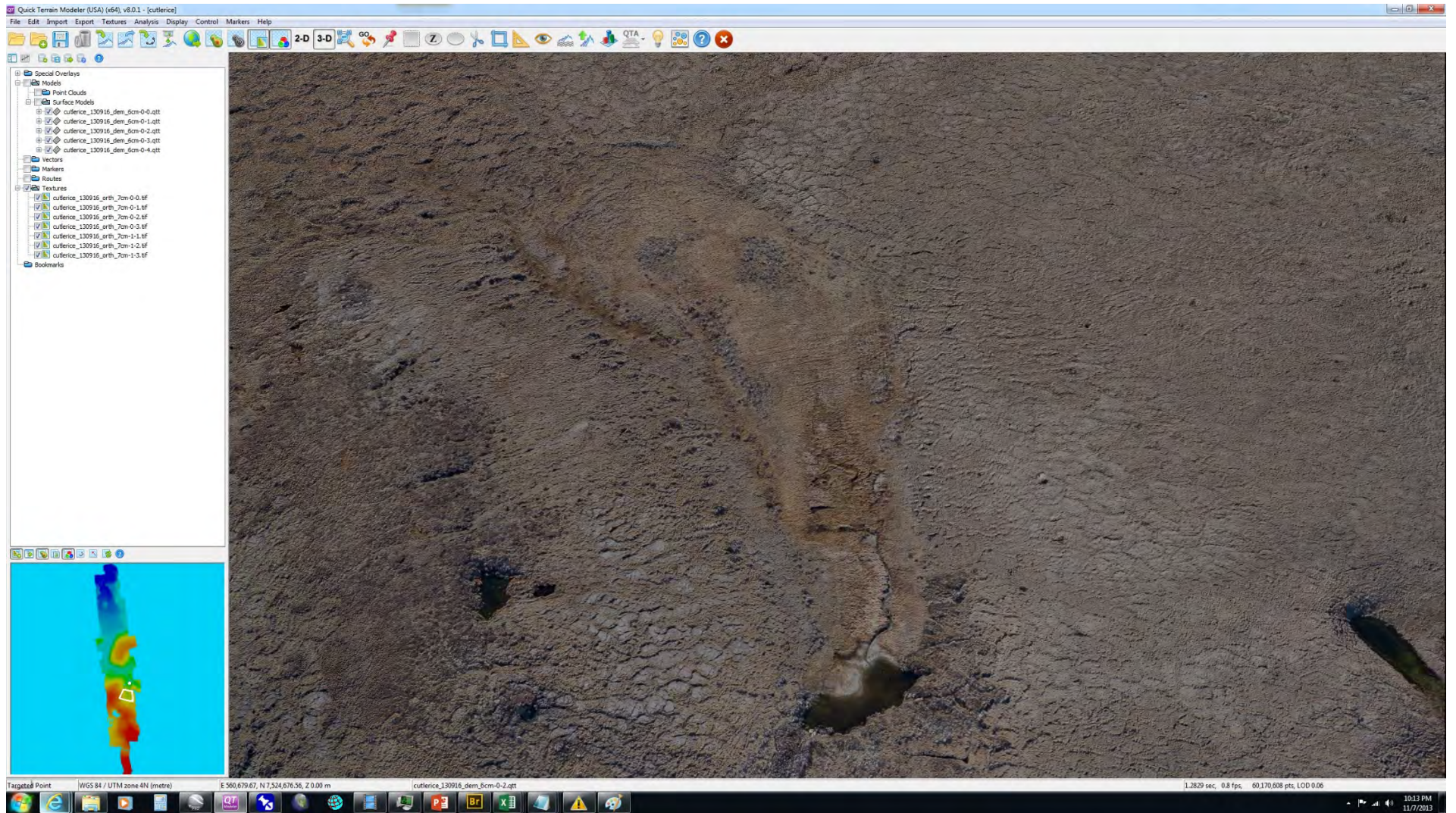
Potential Applications for Time-series of Photogrammetry:

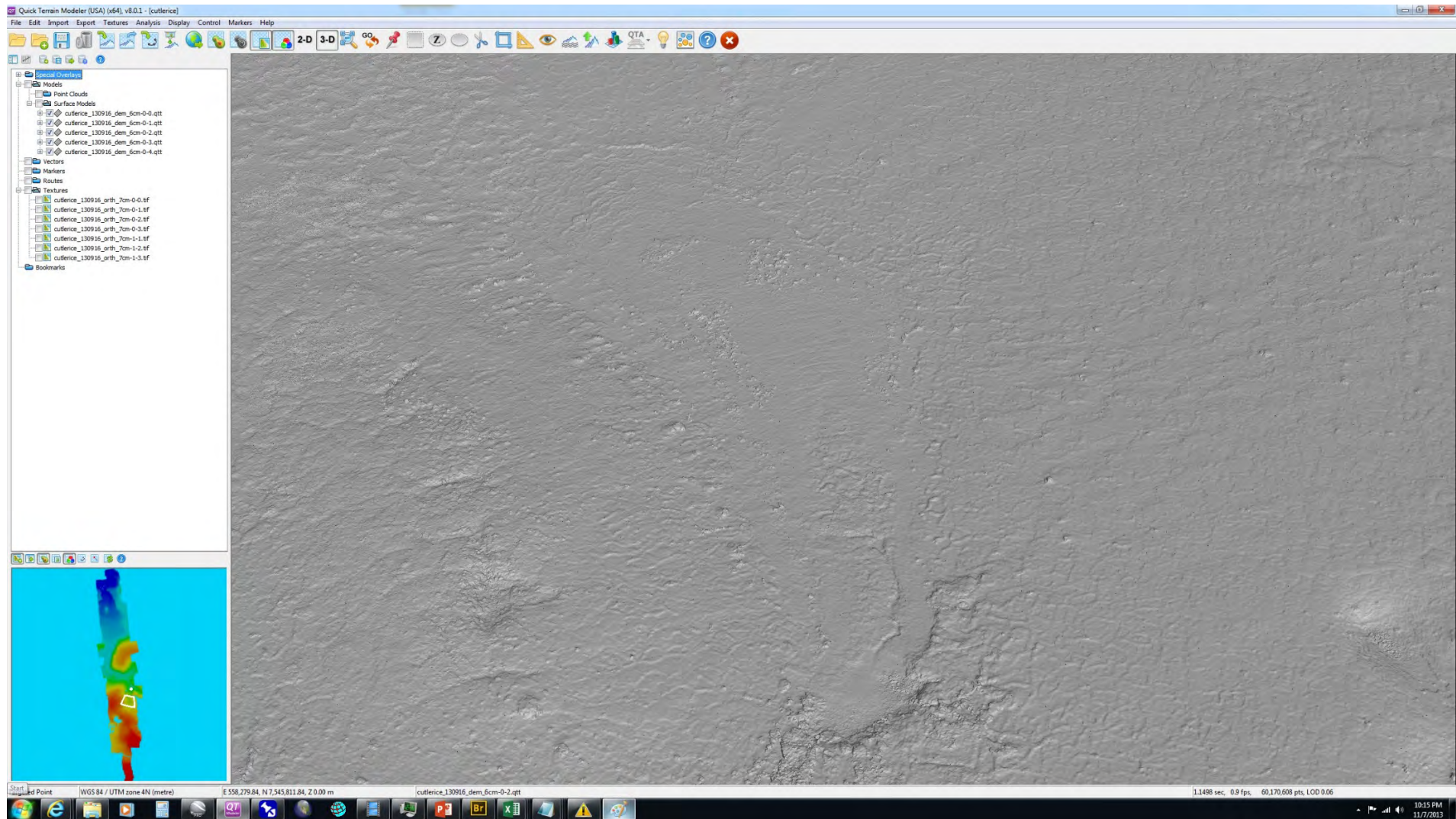
- Glaciology
- Mining
- Permafrost Degradation
- Coastal Erosion
- Vegetation
- Snow
- Natural Hazards: Ice Jams, Forest Fires, Earthquakes

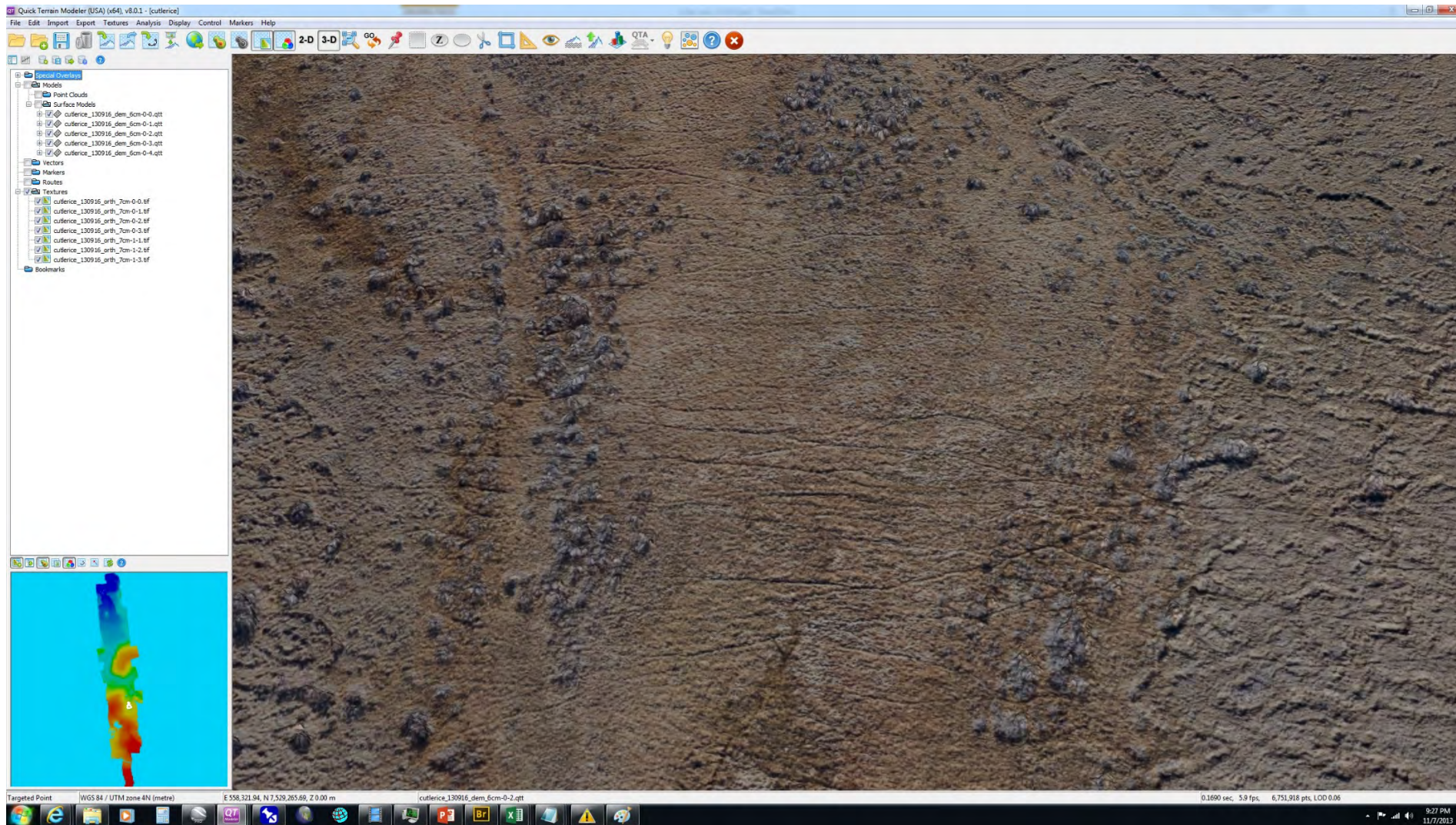
Local Testing Sites

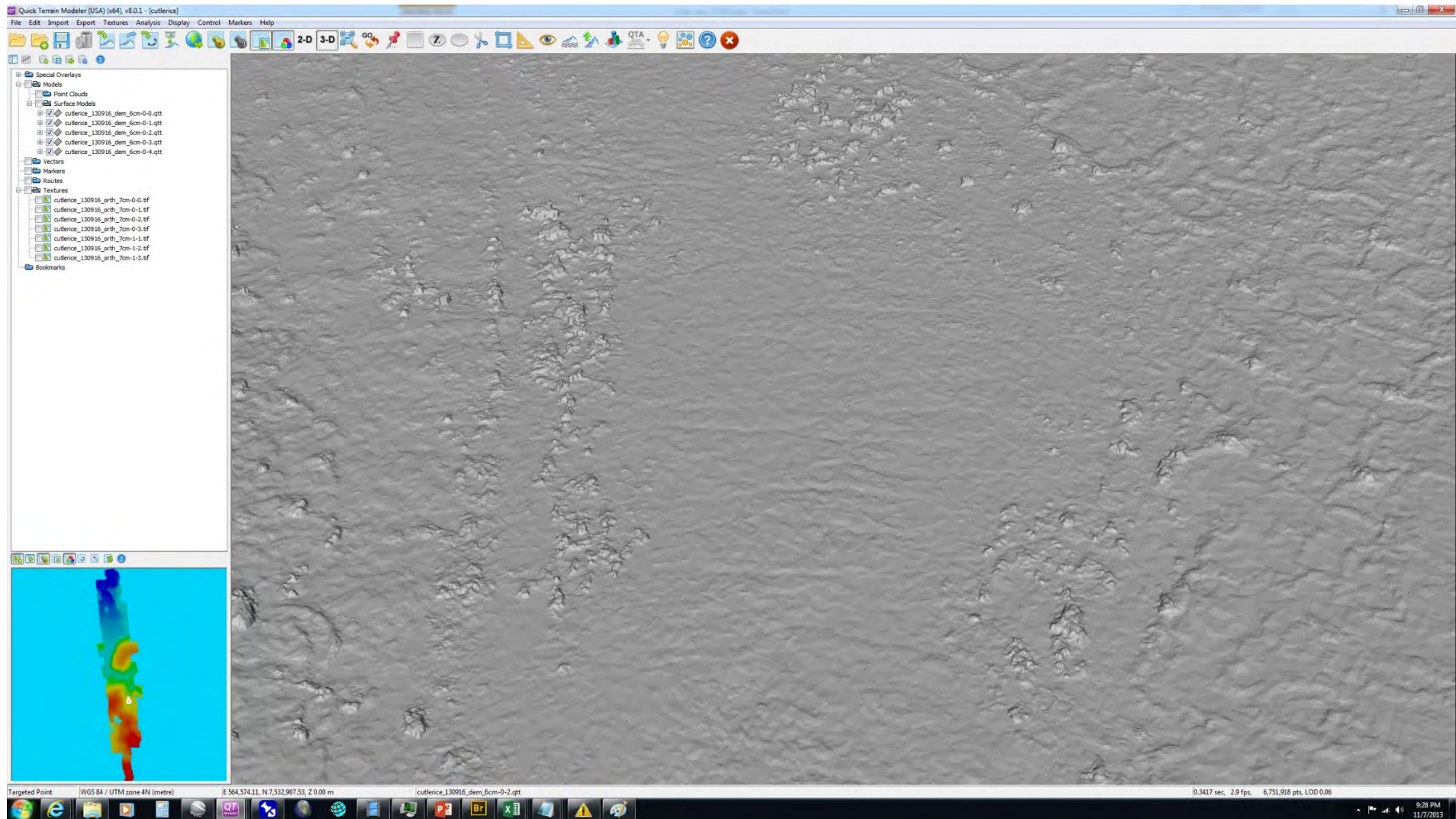


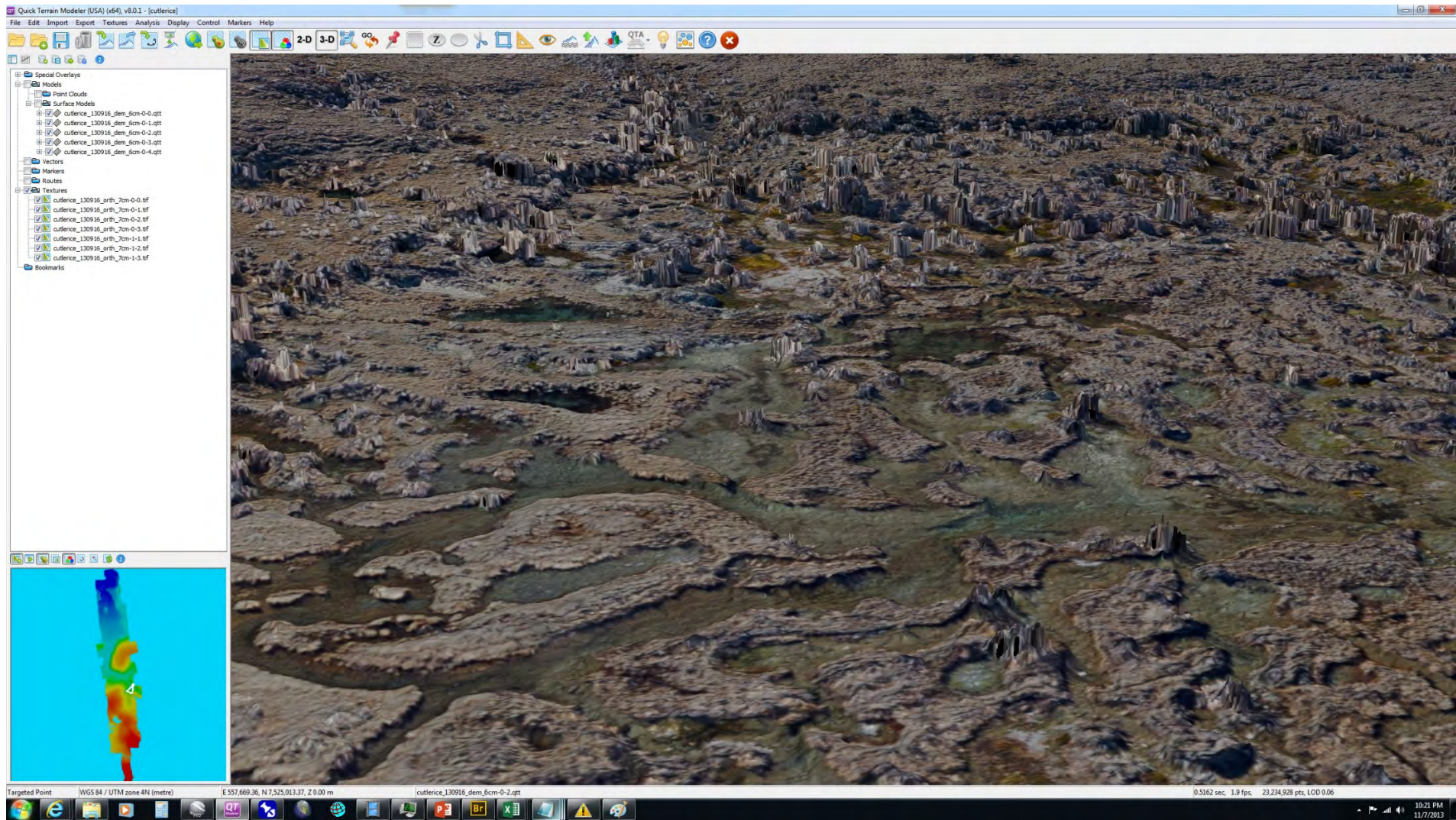
I regularly test and optimize the system to improve it further.
Each of these sites has something unique to offer.



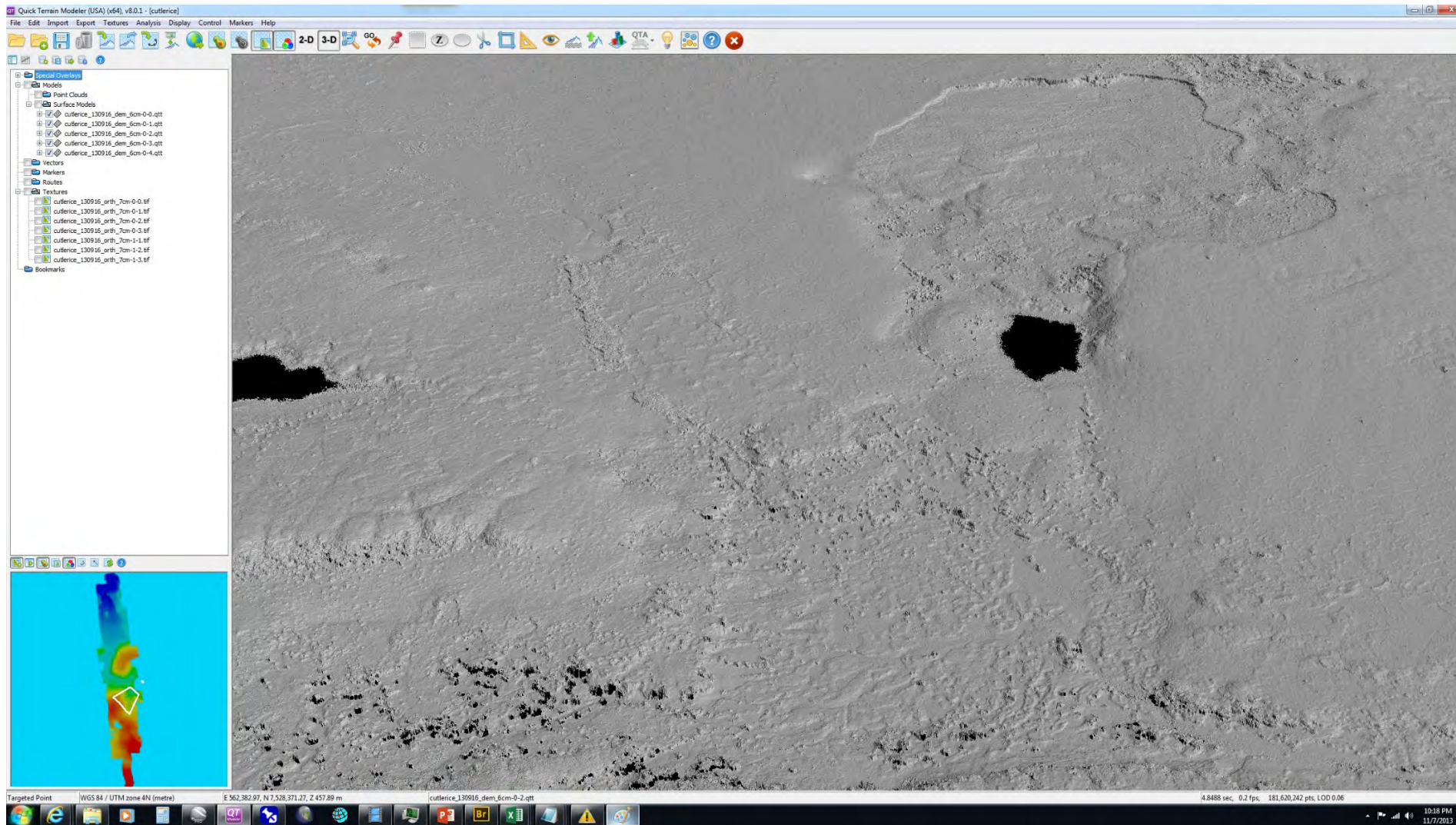


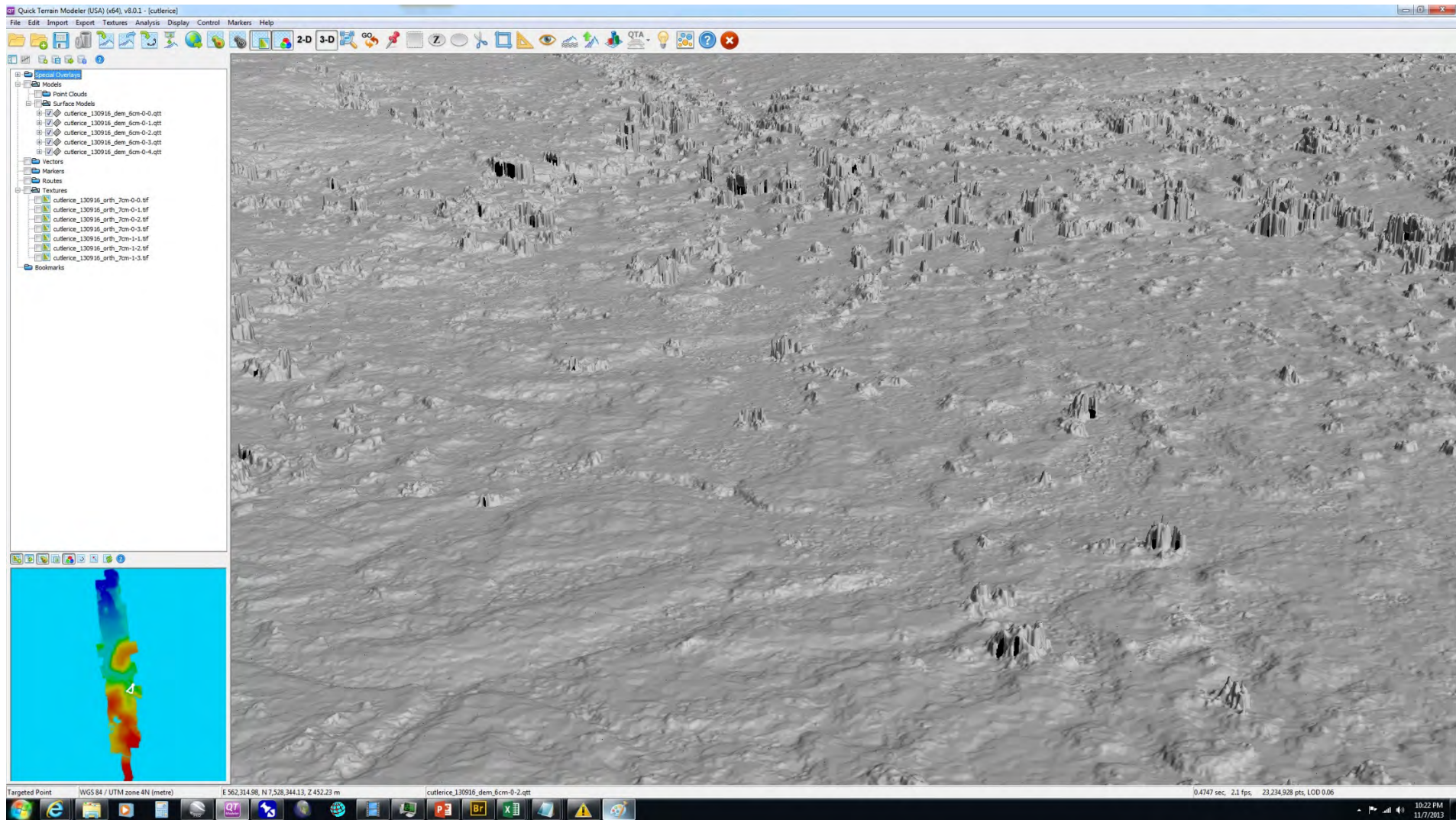












Volume Change Measurements

